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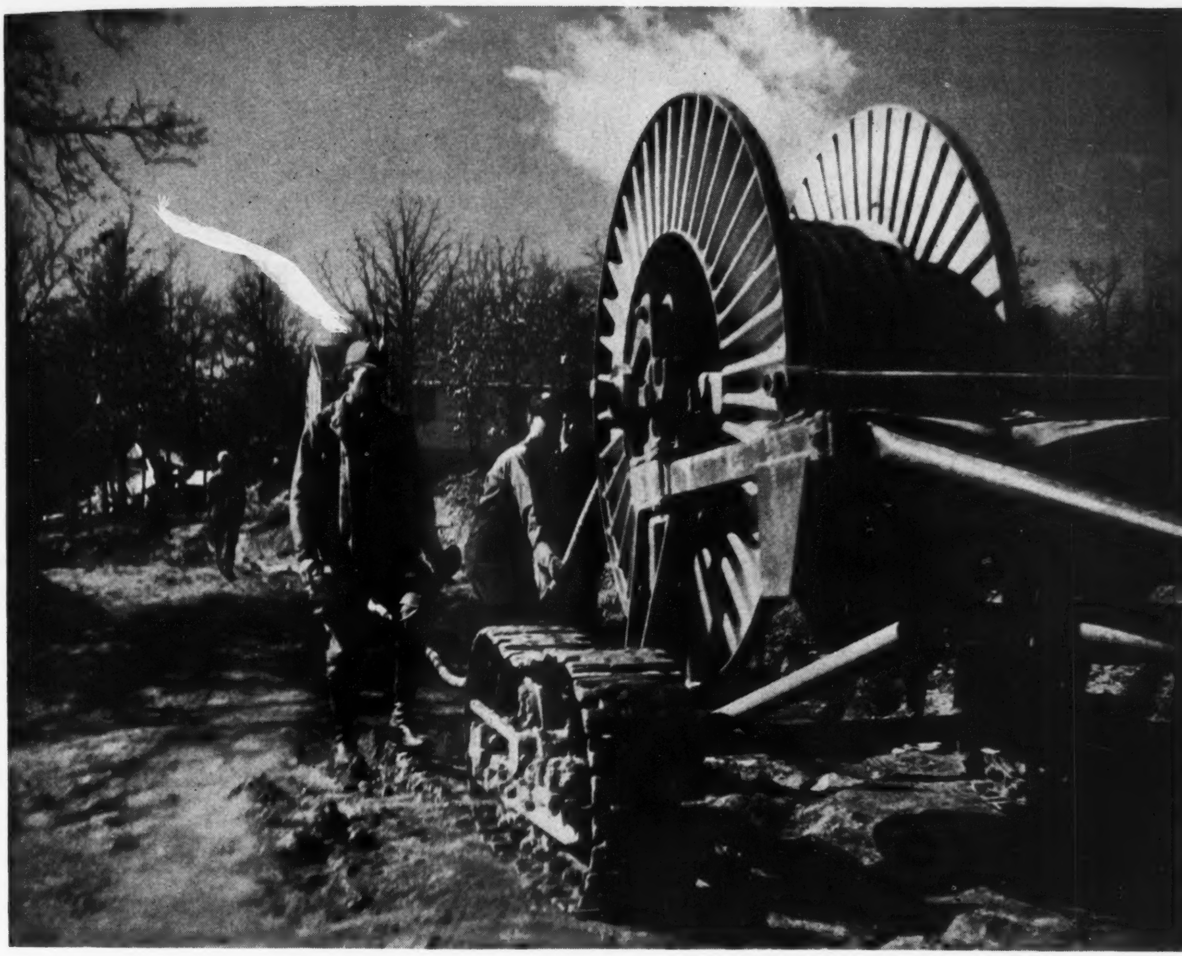


National defense and the Bell System: the Southwestern Bell Telephone Company lays buried cable at Fort Leonard Wood, near Rolla, Missouri

APRIL 1941 VOLUME XIX NUMBER VIII

Remote Control for Reversible Program Circuits

By A. E. BACHELET
Toll Switching Development

WIRE networks over which radio programs are transmitted form extensive systems, with broadcast stations or studios in most of the larger cities interconnected by high-quality circuits employing amplifiers. The transmission over these circuits differs from ordinary telephone transmission in that it is unidirectional and one-way amplifiers are employed. Because a studio may either transmit or receive programs, however, it is necessary to provide means for changing the direction of transmission over the network. This has been done in the past either by using separate facilities which transmit in opposite directions, or by interchanging the input and the output of the amplifiers by the use of patch cords or by switches* which are manually operated.

To provide quicker reversals, a remotely controlled reversing circuit has been developed which permits the reversing of the circuits to be controlled from the studio originating the program. Reversals are effected by relays controlled by direct current transmitted over the two conductors of the program circuit and returned through ground. Any studio may assume control and set up the network so as to transmit the program from it to the other points on the network. As long as this studio retains control, no other studio can alter the conditions; but upon release of control by one, any other studio may assume control, reversing such parts of the network as are necessary to permit transmitting the program to the rest of the network.

The reversing equipment is required at every amplifier point, which may be a simple amplifier station along the line, or a main junction or terminal connecting to a broadcast studio. The basic equipment, which is that required at a cable amplifier station, is shown in Figure 1. It consists of two relays L and M, which

*Record, *Feb.*, 1934, *p.* 162.

receive the control current from the line, and operate relays A and B that change the connections of the amplifiers and other equipment such as equalizers to conform to the desired direction of transmission. A green lamp and a white lamp are also provided to indicate the direction of transmission. With the relays in the positions shown in the diagram, transmission is from east to west, and the white directional light is lighted to indicate this fact. This condition had been brought about by connecting battery to the mid-point of a high resistance bridged across the line at some control point to the east of the amplifier station shown. The direct current resulting was taken from the line at the mid-point of the high-resistance bridge, and operated relay M through a back contact of L. The operation of M opened the circuit of the B relay and allowed A to operate through back contacts of L and B. The operation of A following the release of B closed a contact that changed the connections of the equipment for an east-to-west condition, and lighted the white light.

The battery connection at the control station should be maintained until a change of direction is desired. The control may be released some time before the change is made, if desired. This allows relay M to release, but relay A will remain operated, and thus the circuit will remain in the east-to-west condition. Relays L and M, now being released, are ready to receive operating current from either direction. If some station to the west of the amplifier station is to take control and transmit, for example, a similar direct current will be sent over the line from the west control point, and this current will operate L. When L operates, the holding circuit of A is opened and the B relay is operated through back contacts of M and A. This extinguishes the white lamp, changes the equipment connections for west-to-east transmission and simultaneously lights the green lamp.

These four relays, or equivalent ones, perform the reversing function at all amplifier points, but certain additional relays and keys are added to accomplish a number of other purposes. The A and B relays actually control the reversing changes and light the directional lamps to indicate which direction is in use. Each of these relays is interlocked through a back contact of the other so that only one is operated at a time. The L and M relays—also interlocked through a back contact on the other—receive the

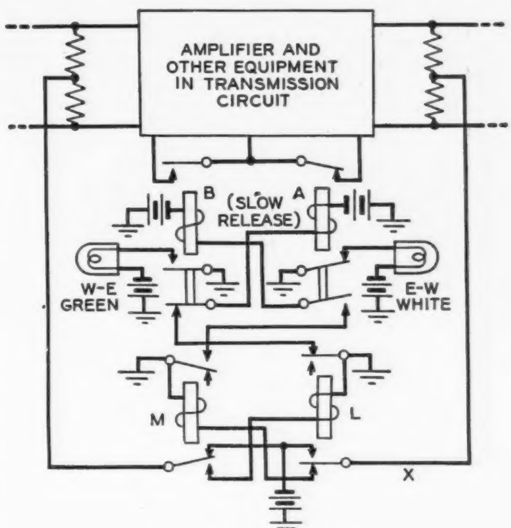


Fig. 1—Schematic of reversing circuit used at amplifier points between two cable sections

control current, and in turn operate the A or B relay. Whichever directional relay, A or B, is operated will remain operated when both L and M are released. This enables a station to relinquish control a few minutes in advance of the next reversal. Both A

and B are given slow-release characteristics so that momentary disturbances on the line will not cause false operation.

Besides controlling its own directional relays, the L and M relays also send a control current over the next section of line. When a control pulse comes in from the east, for example, and operates M of Figure 1, battery will be connected through a front contact of M to the bridging resistance across the west-bound cable, so as to

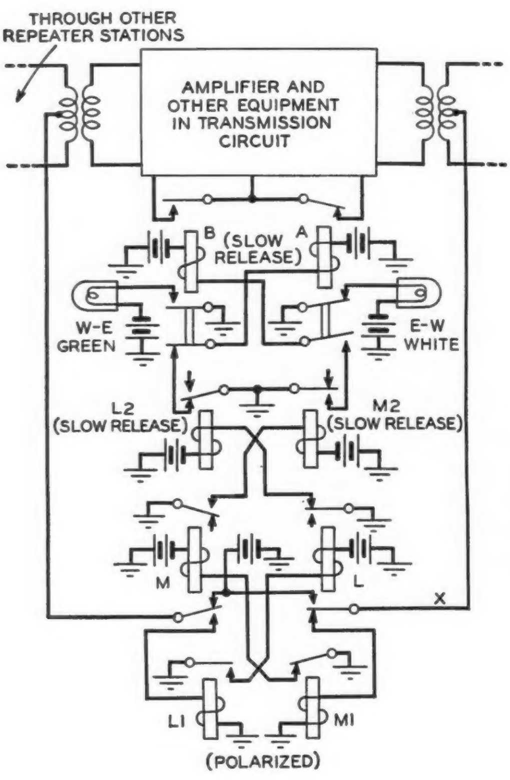


Fig. 2—Transmission-reversing circuit for use between open-wire lines

operate the M relay at the amplifier station next to the west. In a similar manner, this station will repeat to the next, so that control current sent from New York, for example, will reverse all the amplifiers along the line to the distant terminal. As is evident from the diagram, this repeating action works for both directions of transmission. A control current coming from the west will operate L of Figure 1, which will repeat it over the

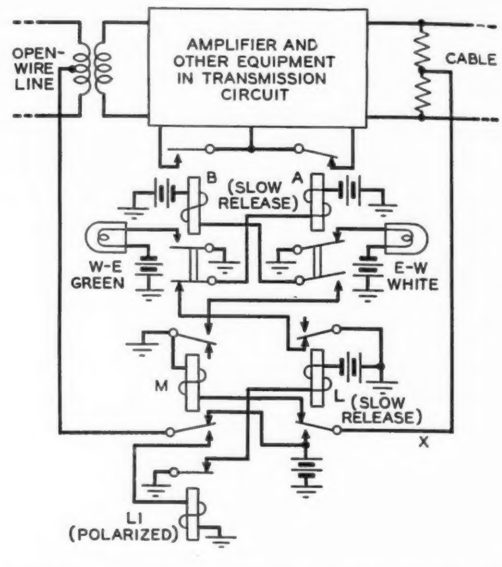


Fig. 3—Transmission-reversing circuit for use at junction of cable and open-wire line

next section of cable to the east, and so on. This repeating of the control current to the next section is not affected by the slow-release characteristics of the A and B relays, and thus the control current is transmitted rapidly over the entire circuit. One thousand miles of cable circuit, with amplifiers located at approximately fifty-mile intervals, may be reversed in a few seconds.

When the amplifier station is between two open-wire sections instead of between two cable sections, additional relays are required to insure satisfactory operation. These are needed because open-wire lines are not only much more subject to outside disturbances than are cables, but have much higher leakage to ground. The circuit arrangement for an amplifier station between two open-wire

sections is shown in Figure 2. It will be noticed that the d-c control path is connected to the line at the mid-point of a repeating coil rather than of a high-resistance bridge. Because of the high leakage of the open-wire lines, much more current must be put on the line to insure that a sufficient amount reaches the distant station to operate the relays, so that the high-resistance feed is not satisfactory.

The current actually reaching the distant end varies widely not only because of varying leakage but because of variations in the ground potential. To make sure the relays do not operate falsely, their minimum operating current must be held to close limits, and for this reason polarized relays are used ahead of the regular L and M relays. These relays are marked L1 and M1—L1 operating L, and M1 operating M. Because of the greater likelihood of disturbances, it is necessary also to provide a greater time delay between the action of L and M and of A and B. This is provided by two slow-release relays, L2 and M2, between L and M and A and B. These enable A and B to "hold in" over longer surges of current than the slow-release of A and B alone would permit.

For amplifier stations between an open-wire line section and a cable section, these additional precautions need be taken only on the side toward the open-wire line. Only one polarized relay is employed therefore, as shown in Figure 3, and the additional delay between the L and M and the A and B relays is obtained by giving either the L or M relay slow-release characteristics. This puts a delay in the d-c transmission path, while the arrangement of Figure 2 does not. It is not satisfactory, therefore, for general use, but since the junctions of open wire and cable are of comparatively rare occurrence, it is permissible to take advantage of the simpler circuit that this arrangement permits.

Where the open-wire section is particularly subject to very wide variations in leakage and ground potential, a "metallic" path over the line is provided for the control current as shown

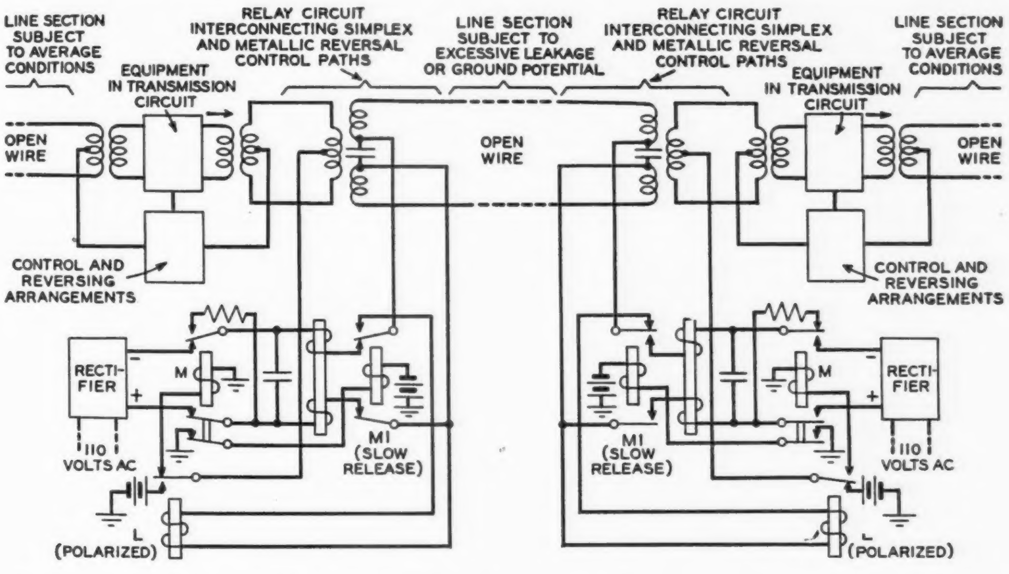


Fig. 4—Metallic control circuit used with open-wire lines subject to excessive leakage or ground potential difference

in Figure 4. The transmission-reversing circuit is the same as Figure 2, but between it and the open-wire line is another repeating coil with a large-capacitance condenser inserted in the line side of the coil. This provides the two feed points for a metallic control circuit, which is arranged in a similar

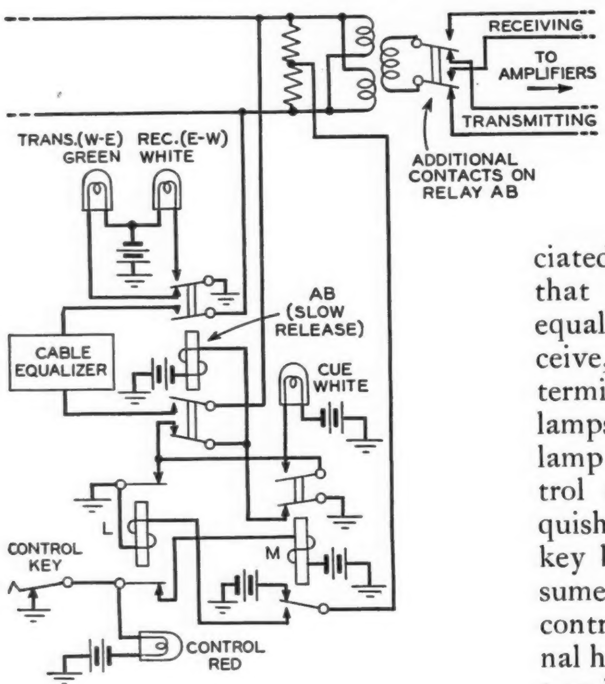


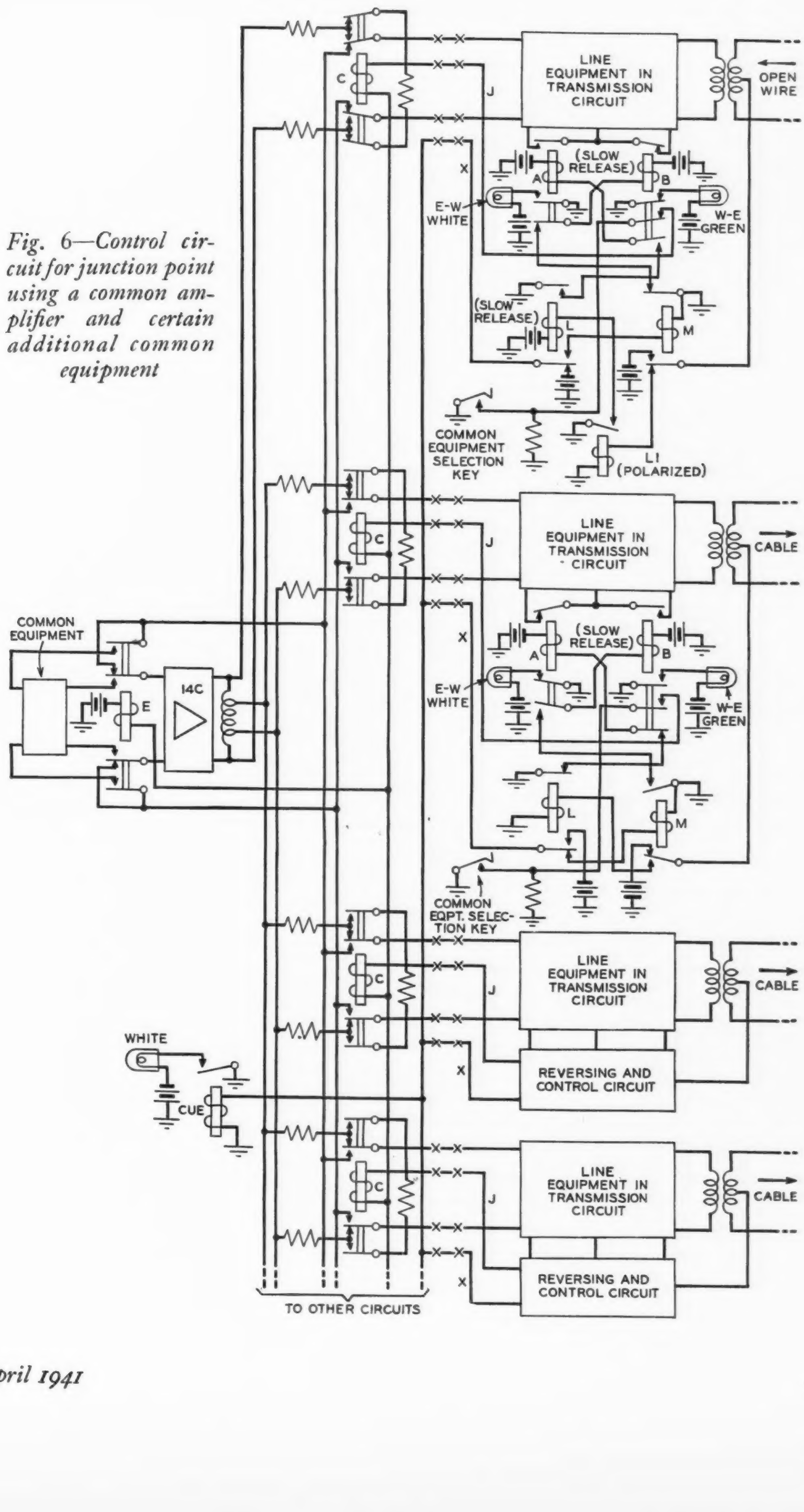
Fig. 5—Schematic diagram of typical control circuit for a terminal

manner at the other end. This circuit also uses a polarized relay, L, for receiving control current from the open-wire line, and an M relay to receive the grounded control current from the local amplifier station. With all relays released, grounded control current from the amplifier station operates M through a back contact of L. M operates MI, and connects d-c from a rectifier to the metallic line circuit. At the other end, this current operates L, which sends a grounded current to the amplifier station. A filter consisting of a retard coil and a condenser is connected between the rectifier and the line. When M releases, a resistance is connected across the line to discharge both the filter condenser and the condenser in the repeat coil to avoid false pulses or clicks in the program circuit due to the discharge current. The slow-release characteristic of MI maintains the connection to the repeating-coil condenser for a long enough time to discharge it.

At a terminal the amplifiers are under control of the broadcasting company, and the only switching of equipment associated with the line required at that point is the insertion of an equalizer when that terminal is to receive, and its disconnection when that terminal is to transmit. Directional lamps are also provided, and a "cue" lamp is added to indicate when control of the circuit has been relinquished. In addition there is a control key by which that terminal may assume control of the circuit. A red control lamp lights when that terminal has control. A schematic of such a terminal circuit is shown in Figure 5. The cue lamp is lighted only when no station has control of the circuit, since it is extinguished by the operation of M, or by the operation of L, if M is released. A single relay, AB, takes the place of the A and B relays at amplifier points, and operates on outgoing control current, and releases on incoming. Its only function is to light the directional lamps, and to insert an equalizer across the line when the direction of transmission is inward, and to remove it when the direction of transmission is outward.

Certain amplifier points act as junctions for a number of lines, and the direction of transmission might be from any one of them to all the others

Fig. 6—Control circuit for junction point using a common amplifier and certain additional common equipment

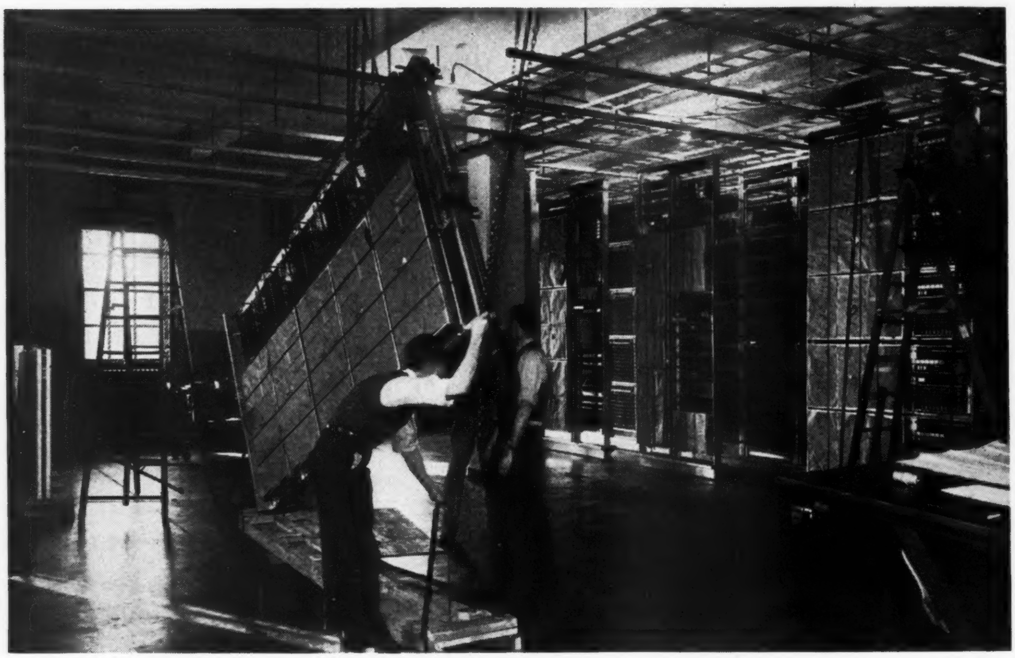


through a bridging multiple.* Under these conditions there would be a reversing control circuit like one of those illustrated above for all the lines. Then by connecting all the leads "x" from the L relays together, the proper reversals will take place as the various lines assume control.

Under these conditions, however, it is frequently more economical to use only a single amplifier to supply all the outgoing circuits, rather than one for each circuit, and possibly a certain amount of other common equipment as well. This is made possible by adding one relay, C, for each line and one common relay, E, as shown in Figure 6. Here, it will be noticed, the X leads are all tied together as already mentioned. In addition another contact has been added to the B relays and the lead from it, J, runs to the added relay C whose winding is in series with that of the common relay E. This latter is a marginal relay, and requires more current to operate than do the C relays. It operates, therefore, only when a "common equipment selection key" is operated for one of the lines. When E is not operated, only the amplifier is used in common, but when one of the "common equipment" keys is operated, E also operates and inserts the additional common equipment.

Throughout the development of this reversing system, stress has been laid upon simplicity of operation and on dependability of service. The remote control feature constitutes an important improvement in nationwide program-network operation.

*Record, *Aug.*, 1940, *p.* 362.



Swinging a unit of crossbar switching equipment into place in a Washington, D. C., central office, as part of a program to increase telephone facilities required by defense activities in the nation's capital. Normal installation periods are being shortened by as much as fifty per cent and it is expected that 22,500 additional telephone lines will be in service by the end of 1941

Detecting Faults While Laying Buried Telephone Wire

By J. B. HAYS
Cable Apparatus Development

INSULATED wires* buried directly in the ground are being used to serve rural subscribers as an alternative in some localities to the familiar one or two-pair open-wire telephone lines. Each pair of such wires has a rubber covering to insulate it from ground, and it is installed about eighteen inches below the surface with a special plow drawn by a truck or tractor. With one present type of plow, three pairs can be installed simultaneously, although the economic advantage of buried wire generally limits long installations to two pairs. The manner of installation is illustrated by the photograph above.

Troubles on an open-wire line, such as broken conductors or insulators, can usually be located without difficulty by an electrical measurement or a visual inspection. With buried wire, however, electrical methods of locating troubles often require considerable time and expense because of the difficulty in accurately locating the high-resistance faults caused by small injuries to the insulation. Visual inspection is obviously out of the question except where the damage is evidenced by a disturbance of the soil.

*Record, *Nov.*, 1936, *p.* 66.

On the other hand, the buried wire is not so subject to disrupting influences as is the open-wire line. Once in place there is little likelihood of its being damaged, but faults may occur while the wire is being buried. To detect them at once, the D-157237 test set has been designed. It is arranged for mounting on the wire-laying plow, and is connected to the conductors of the wire being installed to provide a continuous test of the wire for broken conductors or damaged insulation. It sounds an alarm at the occurrence of such trouble so that the plowing can be stopped immediately. By manipulation of the keys on the set, the type of damage which caused the alarm may be determined. The wire may then be readily removed from the ground for a short distance behind the plow and inspected for trouble.

Fig. 1—The D-157237 test set

This test set is shown in Figure 1. After it has been mounted on the plow together with the reels of wire, the inside end of the wire on the reels is connected to the line terminals of the set, and a ground connection is made to the frame of the plow. At the further end of the pair, the conductors are short-circuited and insulated from ground. When several pairs are being installed simultaneously, the inside ends are connected in series between the line terminals.

The circuit of the test set and its connection to the buried wire is shown schematically in Figure 2. The tube is a cold-cathode gas-filled device with two conducting paths: a main gap and a control gap, as indicated on the drawing. The main gap, which is in series with a 135-volt battery and the winding of a relay, remains non-conducting as long as the voltage across the control gap is less than 72 volts. When the potential across the control gap exceeds 72 volts, current flows in it, and the main gap becomes conducting, permitting battery current to flow through the relay.

Connected in series across the battery are the resistor R1, the conductors of the buried wire, and resistor R2. These form a voltage divider across part of which the control gap is connected. With no fault on the buried wire, the potential across the control gap is that across R2. This potential is set at about 67 volts by

adjusting the variable resistor R1. This voltage is not sufficient to cause the main gap to become conducting, but if a break were to occur in the wire being installed, the voltage divider circuit would be opened, and the full 135 volts from the battery would be applied across the control gap in series with R1. This would cause the main gap to conduct current, and the relay and alarm system to operate. The charging of condenser C at the moment of breakdown gives a small additional current across the control gap to insure sufficient ionization to break down the main gap.

The insulation resistance of the wire appears in parallel with the resistor R1. A decrease in insulation resistance due, for instance, to physical damage to the wire as it is being installed, increases the current through the R2 resistor, and thus raises the voltage across it. If this increase is sufficient to bring the potential to 72 volts, the main gap will become conducting and the relay and alarm circuit will operate. An alarm is thus given both when a conductor breaks and when it becomes grounded.

After the main gap becomes conducting, it remains so even though the potential across the control gap subsequently falls below 72 volts. This enables the test set to give a permanent alarm on troubles which give only a momentary indication, such as a conductor break in which the conductors are immediately pulled back into contact by the tension of the rubber insulation. The set must be restored to normal by temporarily opening the battery circuit.

The action of the test set in detecting low insulation resistance is modified by the capacitance of the buried wire to ground. When a high-resistance ground occurs, the charge on the wire flows through the ground and tends to maintain nearly normal voltage across R1 during the discharge period. As a result, there will be a delay between the occurrence of a damage to the insulation and the operation of the set. The set is so designed that the delay does not exceed 0.5 second when detecting a 20-megohm fault. To prevent a change in sensitivity with different battery voltages and tube characteristics, the set is calibrated from time to time by adjusting the voltage divider circuit when the calibrating resistance RC is connected in place of the insulation resistance of the wire. This adjustment is made by throwing the three-position key to CAL and decreasing the adjustable resistance in the voltage

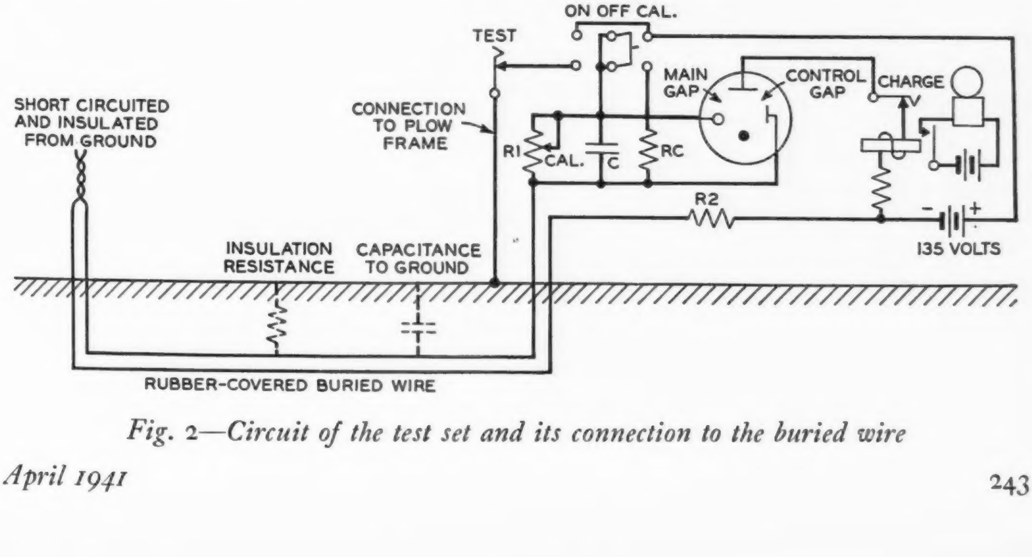


Fig. 2—Circuit of the test set and its connection to the buried wire

divider from maximum until the point is reached where the set operates.

To prevent the set from operating each time it is turned on because of the initial charging current through the buried wire and the condenser c, the battery voltage is removed from the gas-filled tube by holding the CHARGE button depressed for several seconds. This button is also used to restore the set to normal after the alarm has sounded. The TEST button opens the ground connection, and is used to determine whether the sounding of the alarm is a result of a broken conductor or damaged insulation. In this operation the CHARGE and TEST buttons are depressed simultaneously and the CHARGE button released after several seconds. If the bell rings when the CHARGE button is released, the fault is a broken conductor; if the bell does not ring, the fault has been caused by damage to the insulation.

The Pursuit of Curiosity

Curiosity is as good an explanation of the Edison Medal award as I could find. . . .

In the Bell System I have found the greatest opportunity for the pursuit of curiosity. It was a fascinating field 40 *years ago, and during that interval its expansion has been phenomenal, both quantitatively and qualitatively. What was even more important in my own case was that I became a part of a research and development organization with clear-cut goals, high standards of performance, recognition of the importance of the division of labor, and the advantage of teamwork.*

In the Bell Organization, I was assigned assistants who could do many things with greater dispatch and efficiency and perfection than I could. To some of these assistants I later reported myself, and others have carried on the work into difficulties which I myself could never have surmounted.

You will see that it is perfectly natural that I am an admirer of that kind of teamwork which represents a division of labor in the intellectual field. At one and the same time it gives a greater opportunity to those whose talents lie within rather narrow fields, and it results in an integrated product greater than the sum of the individual efforts. For reasons I have just explained, I feel that I am a beneficiary of the group method of attacking scientific problems. Without the collaboration of innumerable associates in the Bell System, the contributions you have designated to be mine I probably should not have succeeded in making. It is a distinct pleasure to me to recall these many associations and to testify that those who have been my colleagues over the years are in large part responsible for the honor of receiving the 1940 *Edison Medal.*

—George A. Campbell,
in his acceptance of the Edison Medal of 1940.

Locating Hits on Telegraph Circuits

By T. A. MARSHALL
Telegraph Development

THE fidelity required in the transmission of telegraph messages makes the detection and localization of a faulty element in a circuit of utmost importance. An interruption of only a few thousandths of a second may cause the misspelling of an important word by a teletypewriter. These short-time interruptions are known as "hits." When they appear, they may be recurrent, and it is essential to locate their source quickly. A single extensive telegraph network* may connect a large number of cities, and hits occurring on any one of the many line sections or associated repeaters may affect the messages at many receiving stations.

Such telegraph networks are usually operated on a half-duplex basis; transmission can proceed in either direction over the line, but when a subscriber who is receiving wishes to send, he must "break" into the circuit by sending a "space" signal of about two seconds' duration. An interruption of this length renders the transmitting equipment at the sending station inoperative, and thus serves as an indication that some other subscriber wishes to send. The short interruption of a hit, however, generally has no effect on the transmitting equipment, and thus the sender is ignorant of its occurrence, but it may cause an error in all the receivers on the circuit. A typical circuit is indicated in Figure 1. Here the subscriber on loop 1 out of office A is represented as sending to all the other stations, and the direction of transmission is indicated by the solid arrows. Should a hit of sufficient duration occur at office X, its effect would be transmitted to all the other offices as indi-

*RECORD, *Jan.*, 1934, *p.* 154.

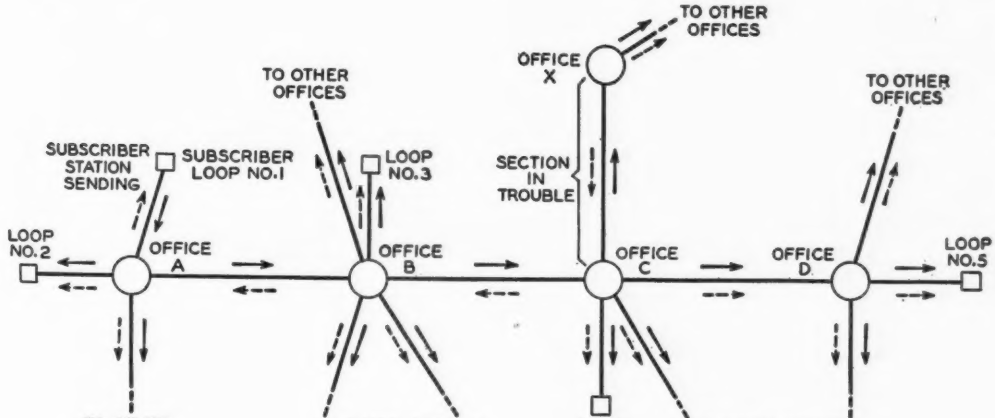


Fig. 1—Typical telegraph circuits. Solid arrows indicate direction of transmission and dotted arrows, the direction of transmission of a hit occurring on the line to office X

cated by the dotted arrows, Figure 1.

Recurring hits are, of course, of infrequent occurrence. On these large networks, however, there is always the possibility of a condition arising

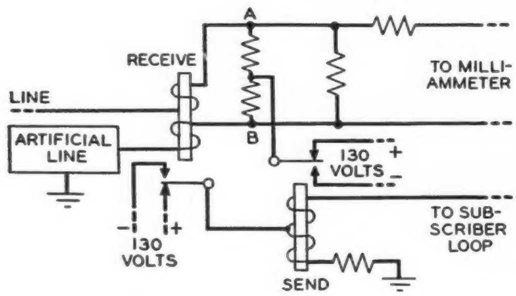


Fig. 2—Simplified schematic of a half-duplex telegraph repeater circuit

at some point that will cause them. Because of the harmful effect of such hits on reception, it is important that their source be promptly located so that a spare circuit or equipment may be put in place of the defective one while the source of the trouble is being more definitely located and removed. The defective messages received indicate when hits are occurring, and the nature of the half-duplex circuit makes possible a rather simple method of determining their location.

A simplified schematic of a half-duplex repeater circuit is indicated in Figure 2. Signals coming in over the line from the left operate the receiving relay, and the armature of this relay—following the telegraph pulses—sends similar pulses out on the loop to the right through the windings of the relay that is sending. The sending relay does not operate because the two windings oppose each other when battery is applied to their mid-point. Signals coming from the right, on the other hand, operate the sending relay and thus connect battery, in accordance with the telegraph pulses, to the two windings of the receiving relay. This relay does not operate under these conditions, but the signals are sent over the line to the left. When signals are being transmitted from left to right, the potential across the points A and B follows the telegraph pulses, but when the signals are being transmitted from right to left, the sending battery establishes no potential across A and B because of the balanced circuit. If a milliammeter were connected across A and B, therefore, it would give a steady reading when transmission was from right to left. Should a hit occur in the line or equip-

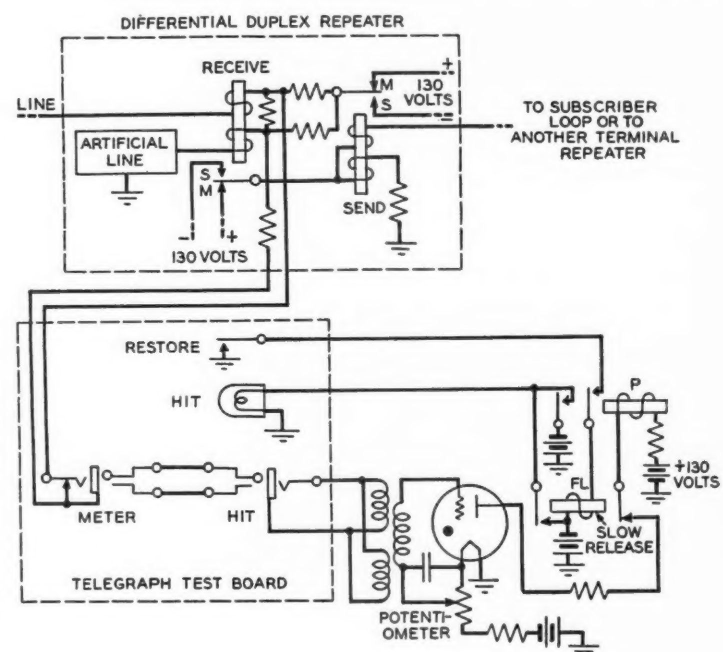


Fig. 3—The 162B1 hit-indicator circuit, shown in simplified form at the right, is "patched" to a telegraph circuit as desired

ment to the left, however, it would cause a momentary deflection of the meter for each hit. In certain instances, especially where the line section to the left consists of separate send and receive paths, as in four-wire metallic circuits, hits may occur on the sending side of the circuit. In this event the meter does not indicate, and the method here described does not lead to a definite location of the trouble.

In the more usual case, a section and its terminal equipment in which hits are occurring may be located by the observation of meters connected at the various offices on the circuit. At each office where the effect of the hit is traveling in a direction opposite to the direction of the telegraph transmission, there will be a deflection of the meter for each hit. Where the hit is traveling in the same direction as the telegraph transmission, however, no deflection will appear. Thus for the transmission conditions indicated in Figure 1, the meters at offices A, B, and C would show deflections, while that at D would not. This would determine that the hit was in some line leaving office C, and with meters on all the circuits leaving this office, the faulty section could readily be located. This method has been used in the past but it requires close attention on the part of the maintenance force. Not only are the meter deflections very rapid, but at many offices there will be a number of them, one for each branch, and they must all be watched simultaneously to see which ones do and which do not deflect.

To simplify this location of hits, the 162-type hit indicator has been developed. It is connected to the circuit in the same manner as the milliammeters, but it includes a gas-filled tube and lights a lamp as a permanent signal each time a hit occurs. This lamp will remain lighted until the circuit is reset, and thus the strain of watching for a number of simultaneous indications is avoided. The new circuit is arranged in two forms, known as the 162A1 and the 162B1. The latter is a low-impedance circuit and connects to the repeater over two wires. Some repeaters, however, are arranged for connecting the meter to the armature of the receiving relay over a single conductor, and the 162A1 is a high-impedance device which is used for this type of connection.

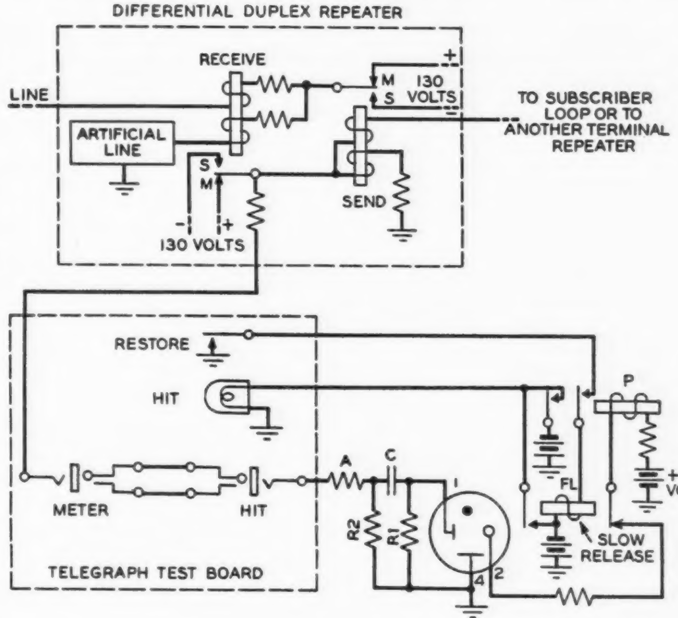


Fig. 4—The 162A1 *hit indicator employs a cold-cathode gas-filled tube with a high-impedance input circuit*

The arrangement of the 162B1 and

its connections to the telegraph repeater are shown in Figure 3. Connections from the circuit of the receiving relay carried to jacks in the telegraph board are already available for use with the milliammeters of previous practice. The hit-indicating circuit is also connected to a jack in the test board, and may thus be "patched" to any telegraph circuit as desired. When a hit occurs, relay P is operated, and lights a lamp as an indication. This lamp remains lighted until the restoring key is operated. This key operates relay FL, which opens the circuit to relay P.

A high-ratio transformer serves as the input to the hit indicator, and its secondary winding is connected across the grid of the hot-cathode gas-filled tube and a potentiometer in the filament circuit. No current will pass through the tube when the grid voltage is more than about eight volts negative, and the potentiometer is set to make the grid about eleven volts negative with no input to the transformer. A hit that will give more than three volts on the secondary of the transformer will cause the tube to conduct, and once the tube becomes conducting, it will remain so until the current through it is interrupted. In this way, a hit lasting only a few thousandths of a second will cause a lamp to light and remain lighted until released. This enables a single attendant to watch a number of circuits simultaneously without the strain of watching for momentary deflections on a number of meters.

For the 162A1 indicator, a very similar circuit is employed except that a cold-cathode gas-filled tube with a high-impedance input circuit is employed. A simplified schematic is shown in Figure 4. The input is connected to the armature of the receiving relay, which—when transmission is proceeding from right to left—remains on its back contact so that the condenser C is charged to 130 volts. Under these conditions, there is no voltage across the control gap, terminals 1 and 4, of the tube, and no current flows through the main gap. When a hit comes in from the left of sufficient value to move the armature of the receiving relay away from its back contact, the condenser discharges through resistances R1 and R2, and in doing so impresses sufficient voltage across the control gap of the tube to make the main gap conducting. From this point on the circuit acts as with the 162B1 indicator.

With either circuit, a change in the direction of transmission will cause the indicators to respond because the receiving relays will be operating intermittently. Whether a lighted lamp means a hit, or merely that the direction of transmission has been changed, is readily determined by holding the restoring key operated. If transmission is now in the opposite direction, the lamp will flash irregularly at a rate determined primarily by the release time of the FL relay.

All the apparatus for these hit-indicating circuits is on a four-inch relay-rack panel that may be mounted in any convenient place in the office. They are provided in lots of four and are multipled so as to appear at several positions of the test board. Besides the apparatus shown, busy lamps and non-interfering circuits are incorporated to prevent the crossing up of telegraph circuits.

News of the Month

Patents

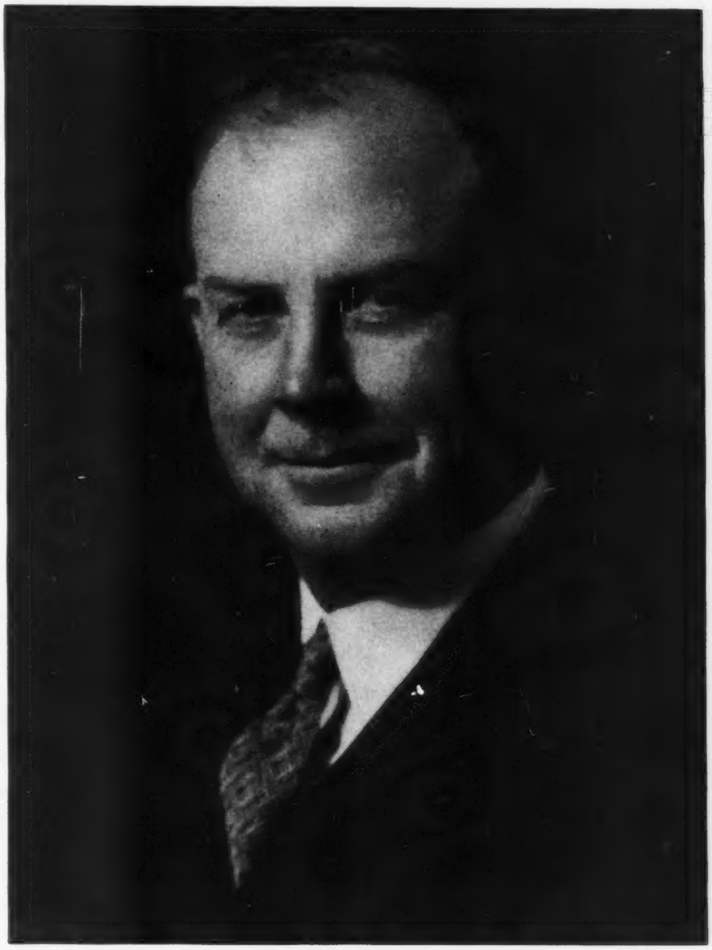
During the year of 1940 a total of 337 United States patents were issued on inventions made by members of the Laboratories. Of these 66 were for improvements in central office systems and apparatus; 28 in station equipment; 119 in wire and radio transmission systems, including carrier systems, short-wave systems, printing telegraphy and image transmission; 83 in general transmission apparatus including amplifiers and vacuum tubes; 12 in outside plant, including wire and cable; and 29 miscellaneous patents including sound recording, manufacturing methods and new materials.

During the year, 510 applications for patents were filed by the Laboratories. Including these there were at the end of the year about 960 applications pending before the Patent Office.

Colloquium

At the February 24 meeting of the Colloquium, Dr. H. A. Bethe of Cornell University spoke on *Energy Production in Stars*. Dr. Bethe has made many notable contributions to various fields of theoretical physics. For his work on stellar energies he received the A. Cressy Morrison Astronomical Prize for 1940. Two years ago he was able to account quantitatively for the energy production in stars of the main sequence by means of a carbon cycle of nuclear reactions.

Dr. W. W. Hansen of Stanford University addressed the March 10 meeting on the subject *General Properties of Cavity Resonators*. Resonators of the "hohlraum" or cavity type are becoming increasingly important in the micro-wave field. Dr. Hansen described and explained some of their properties. Unfortunately, those shapes most useful in practice are not amenable to mathematical treatment, and experimental technique is poor and not much exploited, so there is little precise information. In his talk Dr. Hansen discussed a considerable number



C. F. Craig, Vice President of the American Telephone and Telegraph Company, was elected a Director of Bell Telephone Laboratories on March 5

of shapes capable of exact solution but not of direct practical importance. In this way, one can assess qualitatively the rôle of various important factors, such as the ratio of wave length to skin depth, the volume to surface ratio, and the cross-sectional area to perimeter ratio; and can calibrate his "feeling" for the problem against exactly known cases. This can then be used on shapes not exactly solvable.

Radio Telephone Service for Islands in Chesapeake Bay

On February 14 a trial installation of new radio telephone equipment, developed for island-mainland service for interconnection with the Bell System, was completed and placed in commercial operation by The Chesapeake and Potomac Telephone Company. The project began last November when A. B. Bailey from the radio development group and O. C. Olsen from the trial equipment group supervised the installation of the mainland terminal at Crisfield, Maryland, and the two island terminals at Smiths Island in Maryland and at Tangier Island in Virginia. These islands are located in the center of Chesapeake Bay about twelve miles off the Eastern Shore. The radio-link equipment consists of 15-watt 31A radio transmitters and 31A radio receivers operating at 160 megacycles, or a wave length of 1.9 meters.

In December J. C. Lozier joined Mr. Bailey and Mr. Olsen and lined up the circuits to meet telephone transmission requirements. During the final stages of the work F. H. Willis took active part in radio field measurements. Subsequent to the cutover to commercial service, C. C. Taylor, J. E. Corbin, H. H. Spencer and W. A. MacMaster assisted in making final adjustments to the equipment.

Television Experiments Shown

Experiments in the sharpness of television pictures were shown to the Federal Communications Commission in the Laboratories on March 7. Motion picture films selected for their fine detail were projected under conditions which made the screen image correspond to that from a television receiver with signals of band widths ranging

By defocussing a special motion picture projector, M. W. Baldwin, Jr., produced during the demonstration the effect of narrowed-band width in a television system

from a maximum of 20 megacycles to a minimum of 2.75 megacycles. Other experiments illustrated the effect of changes in the scanning-line structure.

Dr. Buckley greeted the Commission on behalf of the Laboratories. Pierre Mertz described the experiments; D. A. Quarles introduced him and discussed the significance of the work. Apparatus for the band-width experiments was operated by M. W. Baldwin, Jr., who had developed it; the line-structure experiments were devised and performed by F. W. Reynolds and R. E. Graham.

On the same day and on March 11, members of various panels of the National Television Standards Committee were shown the same experiments.

* * * * *

K. W. Waterson, who retired from the Bell System on March 31, has resigned as a director of the Laboratories. He is succeeded by C. F. Craig whose photograph will be found on the previous page.

On March 4, F. B. Jewett took part in the last of a series of broadcasts arranged by the American Institute of Electrical Engineers through the courtesy of the National Broadcasting Company on *Electricity and Defense*. Dr. Jewett and Dr. Karl T. Compton, speaking for the National Defense Research Committee, were catechized by "Mr. Jones, plain citizen," with Dean Barker of Columbia acting as interrogator, as to *What Electrical Research Means to Defense*.

O. E. Buckley has been reëlected to the Board of Education of South Orange-Maplewood and C. S. Knowlton elected to the Springfield Board.

Members of the Laboratories granted leaves of absence to enter military or naval service are J. F. Daly, 2nd Aircraft Warning Company, Signal Corps, Mitchel Field, Long Island; R. D. deKay, Bureau of Ships, Navy Department, Washington; A. J. Engelberg, S. E. Air Corps Training Center, Coast Artillery Corps, Maxwell Field, Montgomery, Alabama; K. J. Ogaard, Company A, 4th Medical Battalion, Camp Upton, Long Island; C. E. Stone, U. S. S. *Zircon;* and N. C. Youngstrom, Third Naval District, New York.

Following a devastating sleet storm in Texas last November, particularly in the Amarillo district, portable emergency radio telephone equipment, described in the Record for February, 1939, page 198, was used to give service to eleven isolated towns. Amarillo itself was isolated and emergency equipment of the Southwestern Bell Telephone Company was rushed from San Antonio to Amarillo and placed in service. Other equipments were obtained from St. Louis and Denver and were used to give service to other communities. As soon as an open-wire circuit was completed to a town the radio apparatus would be moved to another isolated area. Many of the local systems were independently owned and in each case the management of the connecting company was pleasantly surprised to find that the Bell System was equipped to give service with radio links during emergencies.

Members of the Laboratories complet-

Recent developments of the Laboratories are shown to two visitors from The Ohio Bell Telephone Company: R. A. Folsom, Chief Engineer, and J. A. Dawson, Transmission and Protection Engineer, both of the Southwestern Area. In the photograph, from left to right, are J. L. Dow, A. B. Clark, Mr. Folsom, R. S. Wilbur, Mr. Dawson and B. C. Bellows

L. M. Allen
of the Switching Development Department completed thirty-five years of service in the Bell System on March 18

L. S. O'Roark
of the Bureau of Publication completed thirty years of service in the Bell System on the twentieth of March

H. M. Bascom
of the Switching Engineering Department completed thirty-five years of service in the Bell System on March 19

ing twenty years of service in the Bell System during March were L. P. Bartheld, Plant Department; F. S. Entz, Switching Development Department; G. S. Mueller, Chemical Laboratories; A. J. Pascarella, Switching Engineering Department; and Miss Ada I. Van Riper of the Patent Department.

H. G. Arlt, at the Hawthorne plant of the Western Electric Company, discussed finishes for telephone apparatus.

H. A. Birdsall, B. L. Clarke and J. M. Finch attended a meeting of the A.S.T.M. Committee D6 held in conjunction with the New York Convention of the Technical Association of the Pulp and Paper Industry.

K. G. Compton visited Hawthorne and Point Breeze to discuss with Western Electric engineers electroplating problems. Mr. Compton, H. G. Arlt and C. H. Sample attended the A.S.T.M. convention, held during the week of March 8. Mr. Sample has been appointed to the Advisory Committee of the newly formed Committee B8 on electro-deposited coatings.

D. A. McLean and L. Egerton reviewed recent progress in the chemistry of paper insulation and impregnating compounds with General Electric engineers at Pittsfield, Massachusetts. Mr. McLean, with B. Foulds of Electrical Research Products, conferred with representatives of the Army at Wright Field, Dayton, Ohio.

In the February issue of *The Review of Scientific Instruments* are articles by K. K. Darrow, *Debt of Modern Physics to Recent Instruments*, and by F. C. Nix and D. MacNair, *Interferometric-Dilatometer with Photographic Recording*

L. J. Sivian in the December issue of the *Proceedings of the I.R.E.* reviewed the book entitled *Elements of Acoustical Engineering* by H. F. Olson.

H. W. Hermance visited Buffalo and Pittsburgh central offices in connection with studies of panel-contact performance and methods of maintenance.

C. N. Anderson, A. B. Bailey and W. A. MacMaster visited engineers of The Chesapeake and Potomac Telephone Company to discuss proposed radio telephone service for motor vehicles in Washington.

E. E. Schumacher has been elected Chairman of the Papers and Programs Committee and W. C. Ellis a member of the Executive Committee of the Institute of Metals Division of the A.I.M.M.E.

R. M. Burns spoke on *How Metals Corrode and Paints Protect* before the New York Paint, Varnish and Lacquer Association at a

meeting on March 13 at which this association was the guest of the New York Paint and Varnish Production Club.

E. E. Schumacher delivered a lecture on *Metals in Communication Engineering* at Rensselaer Polytechnic Institute, Troy, New York, on March 18.

L. A. Wooten has been elected a National Councilor of the New York Section of the American Chemical Society.

Miss A. K. Marshall, on March 4, spoke on *The Microscopic Laboratory* before Sigma Delta Epsilon, honor science society of Syracuse University.

W. A. Shewhart discussed *Mathematical Statistics in Mass Production* before the American Mathematical Society at Columbia University, February 21. On March 20, Dr. Shewhart spoke on *Use of Statistical Methods in Industry* before the Akron-Canton section of the American Society of Mechanical Engineers.

H. E. Ives and G. R. Stilwell presented a paper entitled *An Experimental Study of the Rate of a Moving Atomic Clock—II* before the American Physical Society and the Optical Society of America at a joint meeting held in Cambridge, Massachusetts, on February 21 and 22. Harvey Fletcher, R. M. Bozorth and C. W. Tucker, Jr., also attended the meetings.

C. N. Anderson spoke on *Sunspots and Terrestrial Disturbances* before the Amateur Astronomers Association at the Museum of Natural History in New York City on March 5.

At the March 7 meeting of the Radio Colloquium, held at the Holmdel radio laboratory, A. G. Jensen discussed the television standards proposed by the National Television Systems Committee.

W. J. Shackelton and C. C. Barber spent about ten days at the National Bureau of Standards, Washington, assisting in installation of special apparatus. While in Washington Mr. Shackelton attended a meeting of the National Research Council's Committee on Fundamental Physical Constants at which the ratio of international to absolute electrical units to be adopted for general use was discussed.

V. E. Legg, on February 20, gave a lecture before the University of Michigan's student section of the A.I.E.E. at Ann Arbor, Michigan, on the subject *Magnetic Materials in Communication Apparatus*. On the next day Mr. Legg delivered the same lecture before the Detroit section of the Institute of Radio Engineers.

P. S. Darnell and N. Botsford were at Kearny in connection with provision of a substitute for aluminum containers for coils, condensers and transformers.

Mr. Botsford and F. Berger went to Providence to examine new coil-winding machinery which is being purchased for the Development Shop.

J. R. Weeks was at Hawthorne in connection with the emergency production of condensers for Government orders.

T. B. Jones went to Kearny to discuss the development of mica condensers.

E. B. Wheeler visited Cleveland on February 13 and 14 to attend a meeting of the American Standards Committee devoted to the revision of the Standards Speci-

W. F. Mayes
of the Circuit Research Department completed thirty-five years of service in the Bell System on March 25

C. F. Seibel
of the Switching Development Department completed thirty years of service in the Bell System on March 6

fications for Dry Batteries.

J. E. Ross was in Point Breeze to aid in the establishment of standards for porcelain protector bases.

H. E. DeCamp of the Hawthorne Works of the Western Electric Company visited the Laboratories to discuss relay development problems.

C. Erland Nelson was in Buffalo where he studied panel-bank contacts.

J. R. Townsend, in Pennsylvania, addressed the Sharon and Pittsburgh sections of the A.I.E.E. on the subject *High-Speed Motion Pictures as an Aid in the Design of Telephone Apparatus.*

E. H. Clark

J. J. Martin, visiting Hawthorne, discussed cellulose-acetate film for interleaving and phenol-fibre sheets.

I. V. Williams and W. Babington, also at Hawthorne, observed the extrusion of special lead coatings on cable.

R. C. Platow spoke on *High-Speed Photography* before the Hillside Fellowcraft Club, February 13, Hillside, Long Island.

Line relays were investigated by C. H. Wheeler and N. J. Eich at the Laurelton office of the New York Telephone Company in Long Island and the Union-Palisade office of the New Jersey Bell Telephone Company; by Mr. Wheeler and R. B. Bauer at the South Chicago and Dearborn offices of the Illinois Bell Telephone Company; and by Mr. Eich at the Bayonne office of the New Jersey Bell Telephone Company.

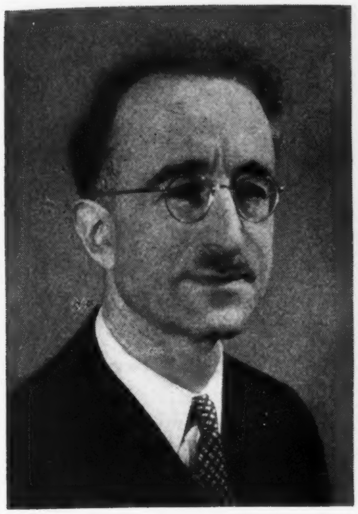
* * *

E. H. Clark of the Systems Development Department, with over thirty-three years of service in the Bell System, retired on February 28. Mr. Clark joined the Engineering Department of the Western Electric Company at Hawthorne in 1910 as an equipment engineer. Previous to this time he had had nearly four years of experience with the Associated Companies in Colorado and Illinois. Mr. Clark came to New York in 1913 to work on the development of circuits for machine switching. The following year he took part in test-

J. E. Kelly
of the General Service Department completed thirty years of service in the Bell System on March 25

P. J. Monahan
of the Plant Department completed thirty-five years of service in the Bell System on the twentieth of March

H. M. Hagland
of the Equipment Development Department completed thirty-five years of service in the Bell System on March 7



J. H. Sailliard

J. M. Watson

O. J. Finch

ing the first semi-mechanical installation in Newark; and when plans for the Metropolitan toll semi-mechanical tandem office were projected, he was assigned to the development of circuits and had a prominent part in the ultimate circuit design for that office which was cut into service in 1920. He also had an active part in the design of sender test circuits for this project. Associated with this work was the development of circuits for the relay call-indicator and later the key-indicator circuit, with which he was closely identified. In 1932 Mr. Clark transferred to the fundamental development group of the Switching Development Department and since then had been engaged in handling routine patent investigations in which he was responsible for analyzing all patents relating to telephone systems.

* * * * *

J. H. Sailliard completed a quarter century of service with the Western Electric Company and the Laboratories on the seventeenth of March. He entered the Engineering Department of the Western Electric Company as a draftsman on printing telegraph equipment in 1916 and three years later became chief draftsman. In 1922 he was transferred to the design group responsible for the development of this telegraph equipment. Along with this work he studied mechanical engineering at Cooper Union from 1918 to 1921 and at Brooklyn Polytechnic Institute from 1924 to 1928.

In 1926 Mr. Sailliard transferred to the machine-switching group where he was concerned with the preparation of specifications and drawings for the manufacture of step-by-step apparatus at the time that the Western Electric Company started to make this equipment. Soon after the Special Products Department was formed he transferred to this group and until 1936 was chiefly engaged in the development of sound recording and reproducing systems, particularly the reproducing phases. In this connection he was associated with the development of sound equipment that could be added to the projection machines theatres were then using. In 1936 he transferred to the Switching Apparatus Development Department on the development of step-by-step apparatus, particularly on problems leading to the reduction of costs of the apparatus. Since last December Mr. Sailliard, in the mechanical design group of the Radio Development Department, has been engaged in the development of radio equipment for aircraft.

* * * * *

On the first of March, J. M. Watson received a five-star emblem signifying his completion of twenty-five years of service in the Western Electric Company and the Laboratories. Mr. Watson joined the Engineering Department of the Western Electric Company in 1915 where he was engaged in the drafting phases of step-by-step systems,

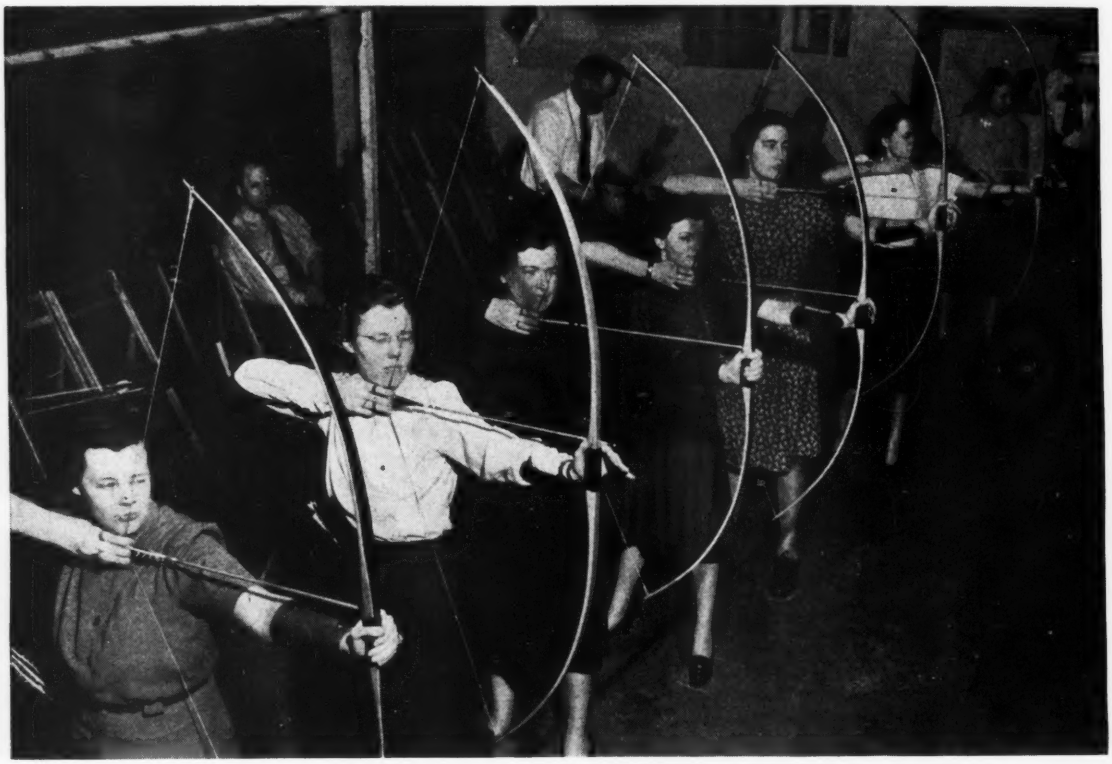
particularly in connection with counter shaft and individual motor drives. A year later he was associated with the engineering and design of a traffic recorder for the 48-trunk panel-type system.

During 1921 and 1922 Mr. Watson was with the card catalog group preparing information on machine-switching apparatus. Following a short leave of absence he returned to what is now the drafting group of the Apparatus Development Department. Since then, except for a period of about two years when he was engaged in establishing standards for drafting and design, he has been checking apparatus drawings, particularly those in connection with central-office dial apparatus.

* * * * *

O. J. FINCH of the Chemical Laboratories completed twenty-five years of service with the Western Electric Company and the Laboratories on the sixth of March. Mr. Finch received his E.E. degree from the University of Minnesota and then spent several years with the General Electric Company in Schenectady, the Allis-Chalmers Company in Cincinnati and the Interborough Rapid Transit Company in New York City. He joined the Engineering Department of the Western Electric Company in 1916 where, in the Physical Laboratory, he did research work in connection with mercury-arc rectifiers.

When the metallurgical laboratory was formed the following year Mr. Finch transferred to this group and since then has been continuously associated with the development and production of magnetic materials, of aluminum and lead alloys, and of brasses, bronzes and steels for a variety of purposes.



The B.T.L. Archers, consisting of a group of about thirty-five members, shoot twice a week during the winter months at the New York Archers' Range. A continuous ladder standing is maintained and at present H. A. Bredehoft is leading the men's section and Florence Duhnkrack, the women's. The photograph shows a portion of the Thursday night group, left to right: Hazel Sutcliffe, Dorothy Storm, Helen Cruger, Annette Brangaccio, Elizabeth Churchill, Jeanette Warnetzka, Florence Duhnkrack, Lois Kolter and L. W. Morrison. Dr. M. H. Manson and H. E. Powell are shown in the background

His first work in this group was on the development of iron-dust cores for loading coils. This was followed by studies of various magnetic materials and he participated in the development of permalloy and its application, in the form of tape, to submarine cables. Since then he has contributed materially in the development of other alloys of iron, nickel and cobalt which are now being widely used in filter networks, in telephone receivers and transmitters, in speech recording and reproducing apparatus and in other communication equipment.

* * * * *

H. A. Affel, Assistant Director of Transmission Development, completed twenty-five years of service in the Bell System on the thirtieth of March. After graduation by Massachusetts Institute of Technology with the B.S. degree in 1914, Mr. Affel returned for two years as a research assistant in electrical engineering. In 1916 he joined the engineering staff of the American Telephone and Telegraph Company, and with the organization of the Department of Development and Research in 1919 became associated with its transmission development group, where he engaged in studies of carrier and radio transmission. In 1929 he transferred to the toll transmission group where his work included the engineering of various types of repeaters, program circuits and carrier systems.

With the transfer of the Department of Development and Research to the Laboratories in 1934, Mr. Affel remained with the same group and soon became Toll Transmission Development Director. In the 1937 reorganization he was placed in charge of the design of carrier repeaters and terminals, voice-frequency repeaters, and voice-operated and radio-connecting systems as Assistant Director of Transmission Development.

Mr. Affel has made a total of over 125 inventions on which patents have been granted or applications filed. He has the dominating patent on pilot-channel gain control for multiplex carrier systems such as is used in the modern broad-band multiplex systems. He also has patents of basic importance in the field of automatic volume control in radio and wire systems. Mr. Affel has also been granted important patents on toll-signaling or ringing circuits for multiplex carrier systems, grouped frequencies with filter separation for two-way multiplex repeaters, and on coaxial line systems.

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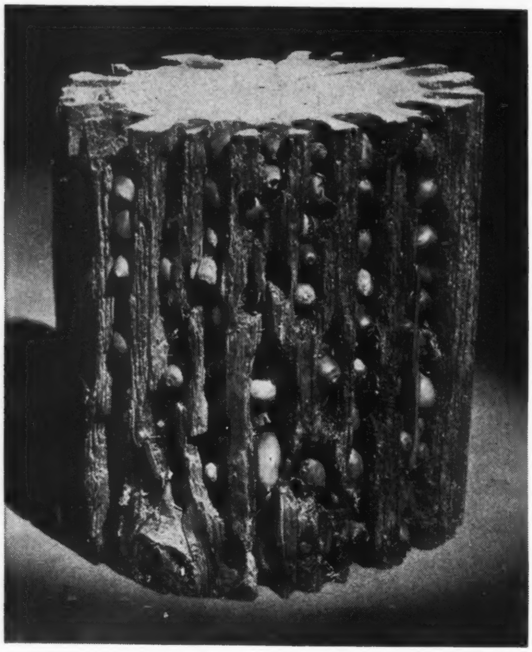
On the twelfth of last month W. A. Weikert received a five-star emblem signifying his completion of twenty-five years of service in the Western Electric Company and the Laboratories. Mr. Weikert joined the Installation Department of the Western Electric Company in 1911. He left the company the next year and until 1917 was engaged in drafting work for a hotel equipment concern. He then joined the Engineer-

H. A. Affel

W. A. Weikert

T. C. Fry



This "woodpecker's storehouse," recently added to our Museum, was taken from a toll-line pole in the Rogue River Valley of Southern Oregon where oak trees are numerous and the acorns are infested with an acorn weevil. Woodpeckers dig the holes in the sapwood, store the acorns, and then, during the winter eat the grubs which have hatched from the weevil eggs. C. P. Toussing, General Plant Manager of the Oregon Area of The Pacific Telephone and Telegraph Company, who presented this specimen to the Museum, stated that it was taken from a 45-foot butt-treated Western cedar pole that had been in service twenty-one years near Medford, Oregon

ing Department of the Western Electric Company and, in the drafting room, had charge of a group of equipment draftsmen. He soon joined the Navy and after a course at Harvard become a radio operator, serving in the first World War for a year and a half.

After the War Mr. Weikert returned to his former work. In 1921 he transferred to the Equipment Engineering Department where he was concerned with the trial installation of panel equipment in Paterson, New Jersey, particularly in connection with district-selector problems. Later he was in the analyzation group of the same Department analyzing central-office equipment orders from Associated Companies. In 1927 he transferred to the Systems Department drafting group and since that time has been a supervisor responsible for the schematic drafting of all telephone systems—manual, dial and toll—and in addition telegraph and radio circuits.

* * * * *

T. C. FRY, Mathematical Research Director of the Laboratories, completed twenty-five years of service in the Bell System on the thirteenth of March. After graduation by Findlay College in 1912 he studied for four years at the University of Wisconsin from which he received his Ph.D. degree in 1920. In 1916 he joined the Engineering Department of the Western Electric Company and since then has engaged in mathematical research on communication problems. Probability, on account of its importance in providing adequate telephone facilities as well as in planning inspection procedure, has been one of his major subjects of investigation; and his extensive knowledge in this field is evidenced in his widely used book on *Probability and Its Engineering Uses*. He is also the author of the textbook *Elementary Differential Equations* and of numerous articles which he has contributed to the publications of societies like the American Mathematical Society, the Econometric Society, and to several others.

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J. B. DIXON, in Branford, Connecticut, attended a Quality Survey Conference on dead-end wires.

A. P. JAHN and C. SHAFER, JR., were in Verona, New Jersey, on February 26 installing special wire guards.

THE ANNUAL CONVENTION of the American Wood-Preservers' Association, held in Louisville, Kentucky, February 4 to 6, was attended by C. H. AMADON, R. H. COLLEY, J. LEUTRITZ, W. MCMAHON and J. G. SEGELKEN. Mr. Segelken presented two papers at the convention entitled *Kiln Drying Longleaf Southern Pine Poles* and *An Electrical Test for Moisture Content in Seasoned Untreated Round Southern Pine Timbers*. S. MASON was joint author of the latter paper. In connection with this trip Dr. Colley visited wood-preserving plants at Gainesville and Jacksonville, Florida; Brunswick, Savannah, and Augusta, Georgia; and Spartanburg, South Carolina.

DR. COLLEY also spoke on *Wood Poles* before the Albany Society of Engineers on January 28 and before the Elmira Engineering Society on March 10.

H. E. MARTING was in Hawthorne on general equipment problems.

C. E. BOMAN inspected the new step-by-step and toll office at South Norwalk, Conn.

R. L. LUNSFORD visited Cleveland in connection with the substitution of new materials for aluminum.

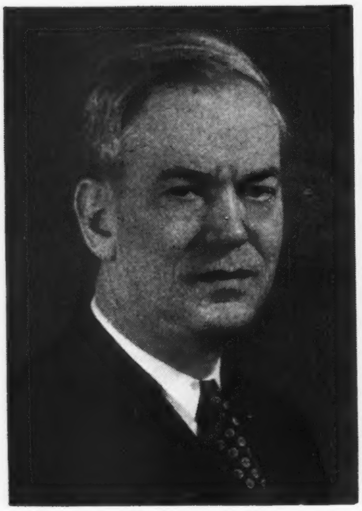
J. NEDELKA, at the Princeton, New Jersey, repeater station aided in the installation of coaxial carrier telephone equipment.

O. C. OLSEN visited the Long Lines operating station at Charlotte in connection with the trial installation of new alarm equipment for type-K carrier telephone system.

* * * * *

IN THE SUMMER of 1912 OLIVER C. HALL worked as a lineman for The Southern New England Telephone Company overhauling the toll line between Hartford and Tolland. In 1914 he was graduated from the Massachusetts Institute of Technology with a B.S. degree. He joined the Long Lines Department of the American Telephone and Telegraph Company at the old New Haven test room and transferred to Hartford as equipment attendant when the first vacuum tube repeaters were installed there. In 1917 he went to Providence for experience in switchboard maintenance and three years later came to the Long Lines Department in New York, working on switchboard specifications and maintenance problems. Early in 1921 he transferred to the Long Lines Engineering Department for work on equipment maintenance. His first assignment was the revision of the equipment trouble routine for reporting equipment troubles, this report being used as a basis of comparison of maintenance effort in various Long Lines offices. Another important assignment was the preparation of Long Lines Plant Bulletin 175 which gathered all maintenance instructions in one bulletin and was the precursor of the Bell System Maintenance Practices.

At the Franklin Printing Company in Philadelphia, R. L. Shepherd checks the press sheets of the March issue of Bell Laboratories RECORD. *From left to right: J. L. McCord, Pressroom Superintendent, Mr. Shepherd and E. A. Palmer, Production Manager*



O. C. Hall

R. S. Bair

J. M. Wilson

Mr. Hall joined the Systems Development Department of the Laboratories in 1929, first working on toll analyzation and then, in the toll circuit laboratory, on various problems including the development of the hit indicator used to detect momentary irregularities in transmission on toll telephone and voice-frequency telegraph circuits. Since 1935, in what is now the Switching Development Department, he has been associated with the development of reversing arrangements for program circuits, toll-signaling problems and, more recently, step-by-step development.

On the thirteenth of March Mr. Hall received a five-star service emblem signifying his completion of twenty-five years of service in the Bell System.

* * * * *

R. S. Bair of the Commercial Products Development Department completed twenty-five years of service in the Western Electric Company and the Laboratories on the twenty-eighth of March. Mr. Bair graduated from the Electrical Engineering course of Newark Technical School in 1915 and came to West Street the following year. He continued his education with a five-year evening course at Cooper Union from which he received a B.S. degree in 1924. In 1917 he joined the Research and Inspection Division of the Signal Corps and spent the following two years in France. Upon his return he entered the Research Department where he concerned himself with radio development. In 1922 he went to Rio de Janeiro for a year where he was engaged in two-way radio communication and broadcasting in connection with the Centennial Exposition celebrating the independence of Brazil.

Upon his return he became intimately associated with the development of the first Western Electric five-kilowatt broadcast transmitter and a twenty-kilowatt telegraph transmitter for the U. S. Army. Two years later he went to Los Angeles to install one of these broadcast transmitters at Station KFI and aided in the installation of others in other sections of the country. In 1925 he was placed in charge of a group which conducted, in coöperation with Boeing Air Transport, an extensive field survey in connection with the introduction of radio telephone service for transport aircraft. Upon the completion of this survey he was placed in charge of a group to develop aircraft radio transmitters, among which were the 8-type for aircraft and the 9-type for aeronautical ground stations both of which were later superseded by the 13- and 14-type respectively. He was also associated with the development of ultra-high frequency police radio equipment such as that installed at Newark, New Jersey; the development of equipment for marine, harbor and coastal services; command sets for the Signal Corps; and liaison sets for the U. S. Navy. More recently he was responsible for

the design of a transmitter, similar to the 14-type, for the U. S. Army Air Corps, a considerable number of which were installed at various points throughout the United States for an "air-alert" network. He was also instrumental in the development of the portable emergency radio telephone equipment (221A) that has been made available to the Operating Companies for use during periods of national disaster such as floods, hurricanes and sleet storms.

* * * * *

AFTER J. M. WILSON received his E.E. degree from the University of Notre Dame in 1911 he joined the Transmission Department of the New York Central Railroad Company where he was field engineer in charge of distribution of electrical construction materials for the electrification project between Hastings and Croton, New York. From 1913 to 1916 he was in the Distribution Department of the Brooklyn Edison Company and was responsible for their original electrolysis survey of all underground facilities. Following this he had charge of the design and installation of a drainage system for electrolysis protection. During this time he was also responsible for the analysis and testing of standard and newly developed apparatus and appliances.

Mr. Wilson joined the Engineering Department of the Western Electric Company in 1916 as an engineer in the Old Physical Laboratory and thus on the twenty-seventh of last month completed twenty-five years of service in the Bell System. His first few years here were spent in investigations of manual apparatus and cable terminals. In 1920 he was placed in charge of a group engaged in analysis investigations of manual apparatus and studies of physical and electrical properties of insulating materials. From 1924 to 1929 his group was responsible for investigating insulating materials used or proposed for use in telephone apparatus. This covered the development of methods of test for the engineering control of their physical and electrical properties. When the Materials Department was formed in 1929 similar work covering metallic materials were added to his responsibilities. Since 1932, in what is now the mechanical apparatus group of the Switching Apparatus Development Department, he has been in charge of analysis investigations of dial and manual apparatus. This work involves critical studies of apparatus capabilities to enable forecasting the operational behavior of the apparatus in the telephone plant.

* * * * *

J. P. HOFFMANN spent several days inspecting an installation of program transmission equipment employing the new multi-line switching feature.

J. M. DUGUID was in Cleveland and Hawthorne on ringing equipment.

J. H. SOLE discussed machine design at the Electric Products Company factory at Cleveland.

H. M. SPICER discussed various types of control and switching equipment at the Palmer Electric and Manufacturing Company and the Albert and J. M. Anderson Manufacturing Company in Boston.

V. T. CALLAHAN observed engine operating conditions at type-J and type-K stations in Colorado, New Mexico and Texas.

F. T. FORSTER attended battery conferences in Philadelphia.

G. A. HURST spent the month of February assisting in the testing and cutover of the Atlantic crossbar office at Lincoln Park, Michigan.

E. W. HANCOCK visited Pittsburgh and Chicago to discuss and observe the new crossbar offices for those cities.

A. B. CLARK and L. M. ALLEN, at Washington and Baltimore, inspected crossbar offices during the early installation stages.

W. I. MCCULLAGH was in Pittsburgh to discuss "through" tests for the Lehigh-Fieldbrook and the Locust crossbar offices, which are in process of installation.

* * * * *

E. D. BUTZ, a former member of the Systems Development Department who retired in 1937 after twenty-five years, died on March 14. Mr. Butz joined the Western Electric Company at Hawthorne after graduating from Pennsylvania State College with the degree of B.S. in E.E. in 1911. He spent a year in educational work with the Installation Department and then transferred to the Transmission Laboratory of the Engineering Department in New York where he was engaged in transmitter and loud-speaker development for seven years.

After the war Mr. Butz transferred to the

E. D. Butz, 1887-1941

J. W. Hillier, 1897-1941

Systems Development Department where he designed and tested step-by-step systems; he taught the step-by-step dial system course in the Out-of-Hour Classes from 1925 to 1930. From 1929 until the time of his retirement he was concerned with the design and development of dial system "A" switchboards. His work involved the development of arrangements for handling step-by-step intercepting service on a centralized basis, of arrangements for a combined toll and DS"A" board for panel offices, and the design of the equipment and facilities for studies of telephone service.

* * *

J. W. Hillier of the Development Shop, with over twenty-one years of service in the Engineering Department of the Western Electric Company and the Laboratories, died on February 24. During the World War Mr. Hillier served with the 628th Aero Supply Squadron. Returning to civilian life he immediately joined the Development Shop as a tool and cutter grinder. Four years later he transferred to the machine group of the Shop where he had since been engaged on lathe and milling machine work. He had been active in the Bell Telephone Laboratories Employees' Association and was for a time its president. Mr. Hillier was one of the outstanding golfers of the Bell Laboratories Club and since 1925 had played in a majority of its tournaments and represented the Laboratories in a number of inter-company matches. He had also been a member of the Men's Bowling Club since 1921.

* * *

Charles A. Bolin, a former member of the Equipment Development Department who retired from active service in 1932, died on February 28. He joined the Western Electric Company in 1902 at Hawthorne and because of his long experience with switchboard cabling layouts for central offices was transferred to New York early in the development of panel systems to work on their cabling layouts. Later he worked on trial installations of newly developed systems.

* * * * *

H. D. Bruhn of the Equipment Development Department died on March 8. Mr. Bruhn received an E.E. degree from Ohio Northern University in 1912 and immedi-

C. A. Bolin, 1871-1941

H. D. Bruhn, 1890-1941

ately joined the student course of the Western Electric Company at Hawthorne. Upon the completion of this course he entered the equipment section of the Engineering Department where he engaged in the development of central-office equipment.

Mr. Bruhn transferred to New York in 1919 and became associated with the development of machine-switching equipment in the Systems Development Department. Since 1922, in the local systems group of the Equipment Development Department, he had been concerned, both in an engineering and a supervisory capacity, with the development of new equipment for manual and dial private-branch exchanges, order-receiving turrets and a variety of key-switching and intercommunicating systems.

* * * * *

J. T. Dixon and H. E. Curtis attended the Broadcast Engineering Conference at Ohio State University during February.

E. A. Potter was in Joplin, Missouri, in connection with the installation of lightning protection equipment along a portion of the Kansas City-Joplin buried toll cables.

Transmission measurements were made by G. B. Engelhardt and A. F. Pomeroy to determine effects of temperature on the aerial cable at Princeton.

Mr. Engelhardt and T. Odarenko made echo measurements on type-J entrance cables at Jacksonville, Florida.

H. H. Benning, M. E. Campbell and L. H. Morris made equalization studies and load-carrying tests on the Stevens Point-Minneapolis cable at the Minneapolis office. K. C. Black inspected the arrangements along the cable for the installation of final equalizers. S. Rosen was at Eau Claire, Wisconsin, for development studies on an automatic coaxial switching circuit.

J. R. Brady, C. C. Fleming, J. J. Jansen, and R. J. Shank went to Minneapolis to set up terminal facilities for sending television pictures over the Stevens Point-Minneapolis coaxial cable.

R. S. Hawkins was in Philadelphia in connection with a video television circuit set up for the Philco Company.

S. T. Brewer has been in charge of the maintenance of the New York-Philadelphia cable during recent transmission tests.

G. B. Thomas, at Chicago, attended the American Management Association Conference on Industrial Relations.

R. S. Caruthers and R. D. Fracassi have returned from Philadelphia where they were working on a double-sideband carrier-program channel.

The Laboratories were represented in interference proceedings at the Patent Office by G. C. Lord before the Board of Appeals and by W. L. Dawson before the Board of Interference Examiners.

O. D. M. Guthe was at the Patent Office to appear before the Board of Appeals relative to an application for patent.

The course of lectures on *Mathematics and Mathematicians in Industry* which is being presented by the Communication Group of the New York section of the A.I.E.E. includes a general survey of the subject by T. C. Fry and a talk on *Mathematics in Communication* by H. W. Bode. This course has been planned by the Related Activities Committee of which E. I. Green is a member.

One Out of Four

At the end of 1940 *there were* 322,000 *employees in the Bell System, including the Bell Telephone Laboratories and the Western Electric Company. Of these* 83,150, *or more than one out of every four, were making use of the salary deduction plan for carrying life insurance to protect their families. Their insurance amounts to* \$259,350,000 *and the premiums paid through the plan during* 1940 *were* \$8,400,000.

Information as to life insurance is available to members of the Laboratories through Lloyd H. Bunting, Insurance Counselor. Mr. Bunting can be consulted without incurring any obligation of any kind. His telephone is Extension 264.

Report of Employees' Benefit Committee

A REPORT of payments under the "Plan for Employees' Pensions, Disability Benefits and Death Benefits" that were made during 1940 is given below:

Pensions	$187,801.60
Accident Disability Benefits and Related Expenses	8,488.74
Sickness Disability Benefits	179,656.10
Death Benefits	62,489.18
Total	$438,435.62

At the close of the year service pensions were being paid to 104 retired members of the Laboratories and in addition twenty others were receiving disability or special pensions. Fourteen members of this pension roll were retired in 1940: five under the Retirement Age Rule, eight because of disability and one at his own request.

Thirteen active and four retired members of the Laboratories died during 1940. In all but two of these cases eligibility to Death Benefits or other payments under the Plan existed and, accordingly, such payments were authorized. A Death Benefit payment was also granted to the dependent beneficiary of a former employee who died in 1940 as a result of an illness which was incurred while he was an employee and continued until his death.

There was a decrease of approximately twenty-three per cent in the number of accidents occurring per 1,000 employees at the Laboratories in 1940 as compared with the average per year for the five preceding years. However, payments of accident disability benefits and related expenses per $1,000 of payroll were more than double the average annual rate for the preceding five-year period. This was due largely to the occurrence of several injuries which involved extended loss of time; one, in fact, accounted for thirty per cent of the total time lost for all accidents during the year.

From a sickness viewpoint 1940 was neither an exceptionally good nor exceptionally bad year. Sickness benefits were paid, to employees eligible under the Plan, for 768 absences of more than a week's duration. This was a slight increase, per eligible employee, over the average number per year for the preceding five years. Payments increased at a somewhat higher rate, due partially to the amendment to the Benefit Plan effective January 1, 1940, which extended the full-pay disability allowances of employees with fifteen years or more of service. In addition to disability benefits under the Plan, payments totaling $219,229 were made to employees absent on account of sickness. Approximately seventy-five per cent of this covered payment for short absences of less than a week's duration. The balance was for the first week of absence in benefit cases, before the beginning of Plan benefits, and for absences of more than a week's duration of employees not eligible to benefits.

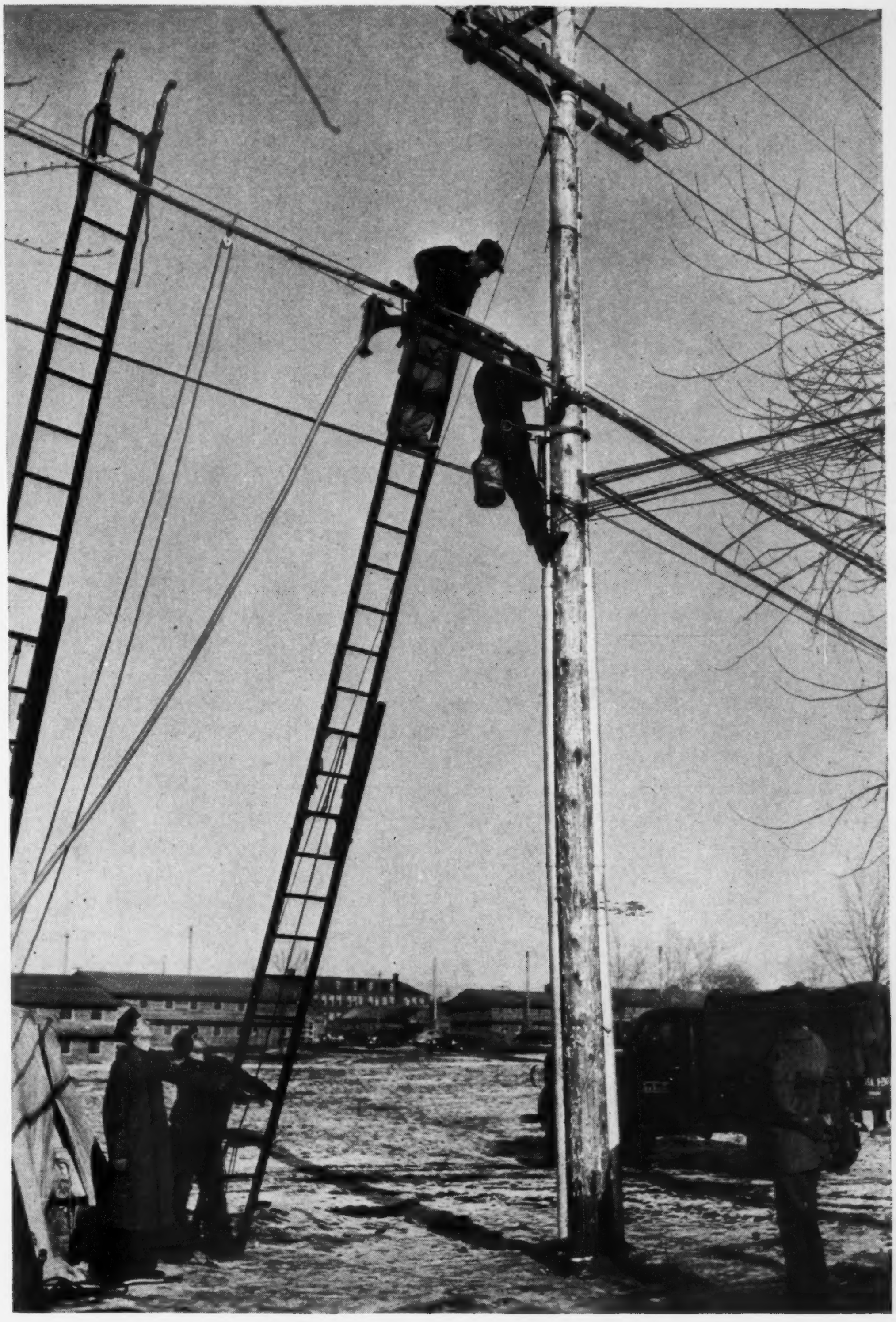
Supplementary payments in the form of Special Benefits and Supplementary and Special Pensions, totaling $17,113, were paid to active and retired members of the Laboratories in need of special assistance during 1940. Of this, $7,794 was granted to employees whose sickness absences began prior to the amendment to the Plan mentioned in the foregoing paragraph, in order to provide these employees with payments equal to the benefits they would have received had their absences fallen within the regulations of the amended Plan.

The Benefit Plan is administered by a Committee consisting of R. L. Jones, Chairman, E. W. Adams, A. B. Clark, J. W. Farrell, M. J. Kelly, L. Montamat, G. B. Thomas and W. Wilson. J. S. Edwards is Secretary of the Committee and G. A. Brodley is Assistant Secretary.

J. S. EDWARDS, *Secretary*
Employees' Benefit Committee.

The above statement of payments made in 1940 *audited and found correct.*

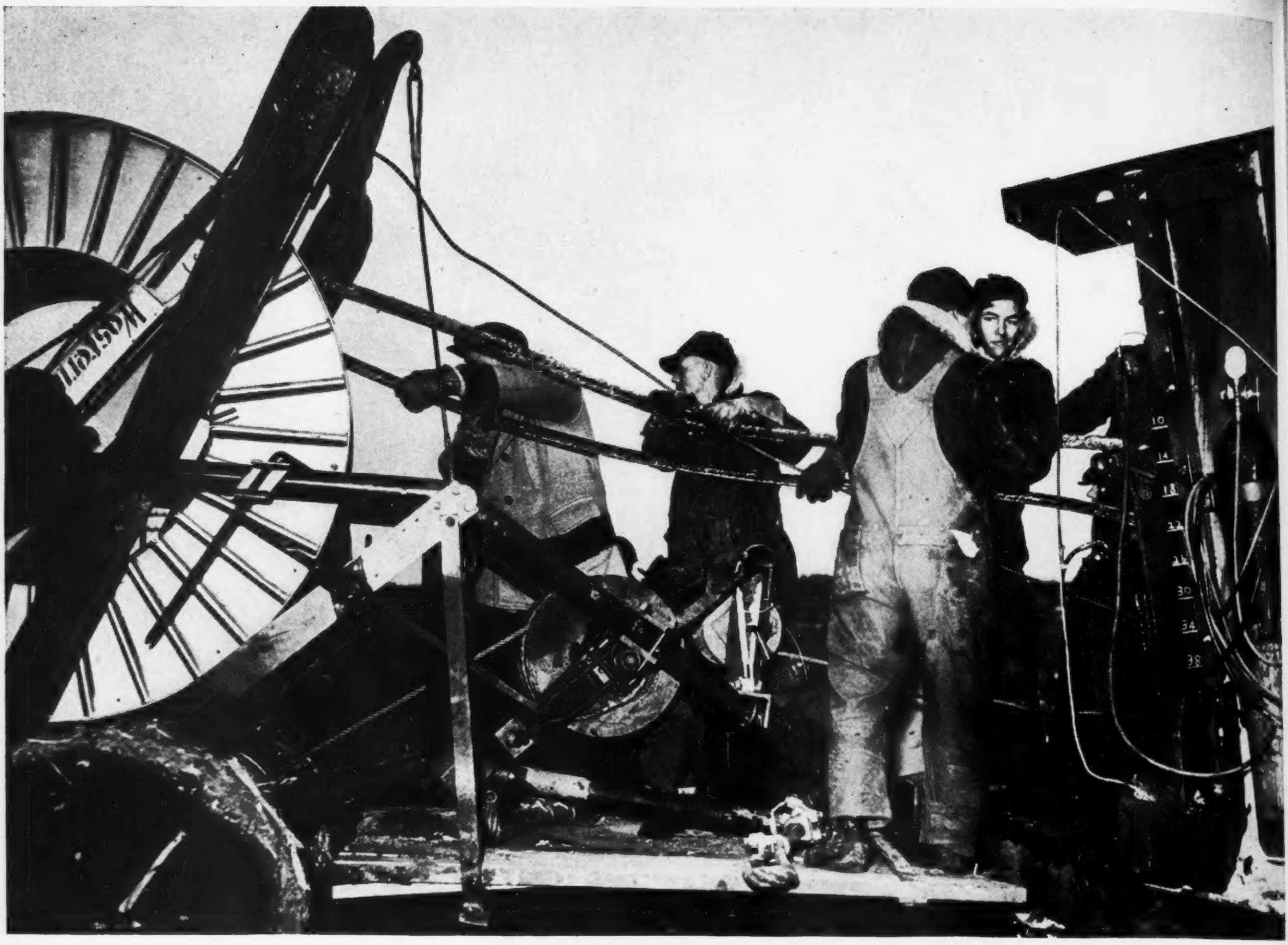
E. J. SANTRY, *General Auditor.*



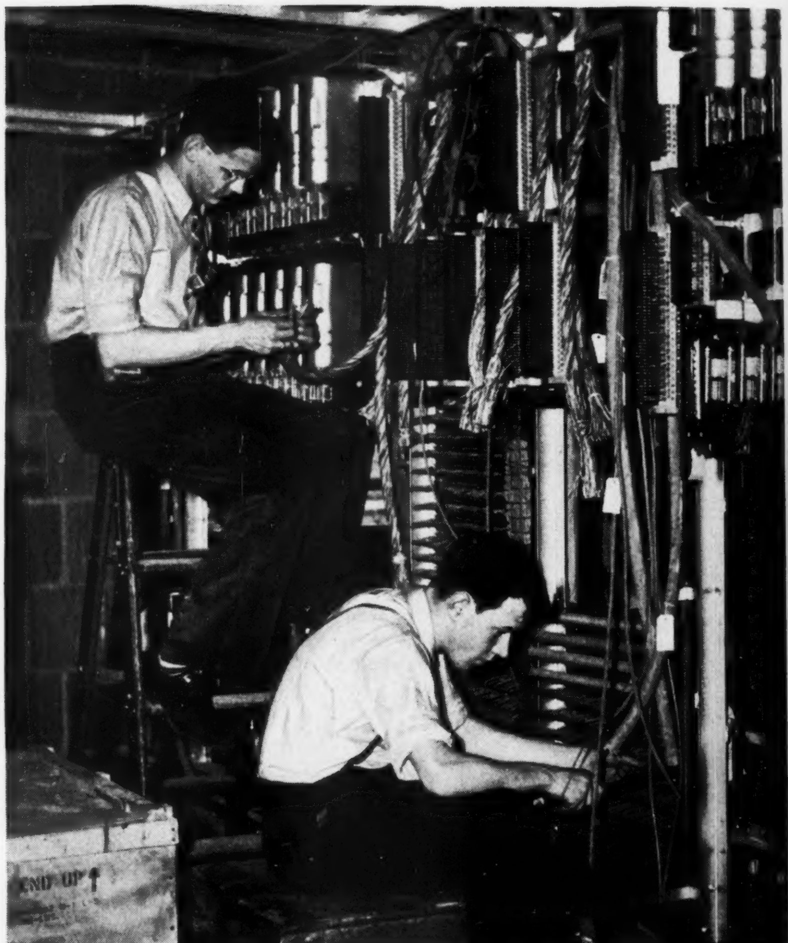
At Fort Custer, near Battle Creek, a Michigan Bell crew installs a new 303-pair cable

NATIONAL DEFENSE *and the* BELL SYSTEM

Telephone companies are rapidly putting in new poles, cables, switchboards, to care for the many additional needs for service occasioned by the National Defense Program. Works and warehouses of Western Electric are meeting difficult schedules, in order that construction crews may receive a constant flow of materials. Throughout the United States the work goes forward as shown in these pictures from widely scattered places



On their way to Sacramento, this Long Lines crew plows in cable across Northwestern Bell territory to increase the security of transcontinental circuits



Greatly expanded activity at an arms factory in Connecticut required the installation of this new PBX by The Southern New England Telephone Company

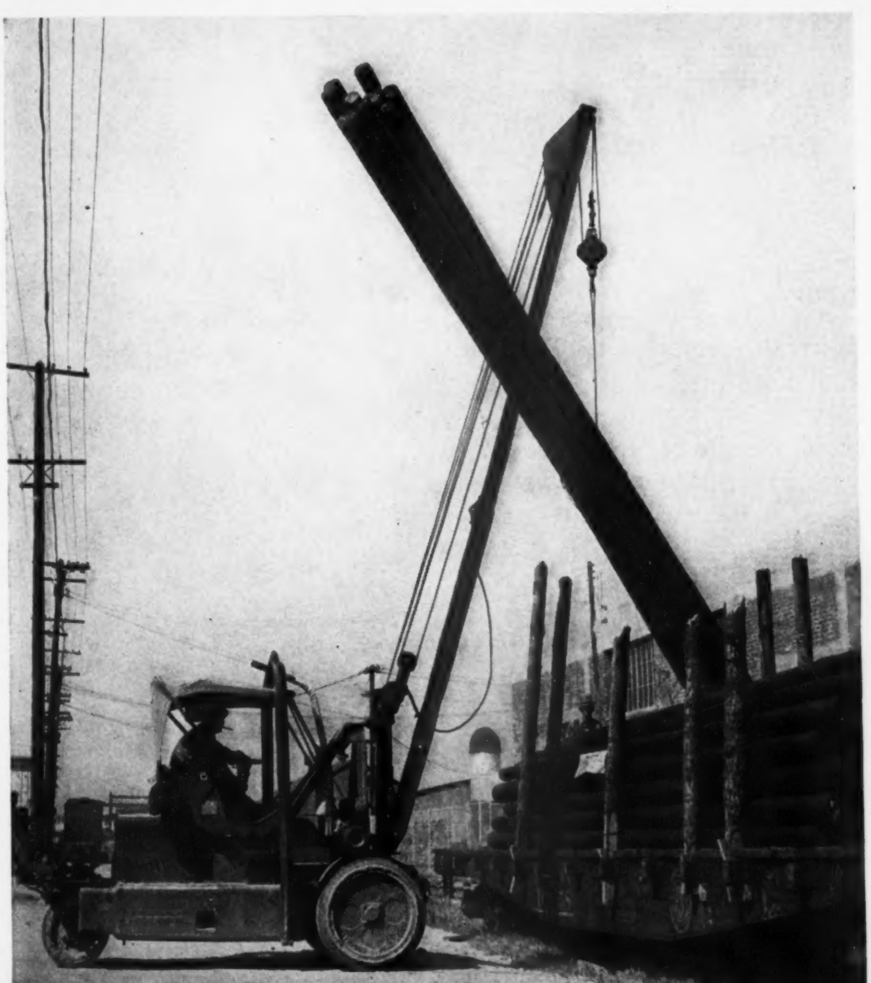
As Illinois Bell men guard the cables, a metal building housing a dial PBX is lifted to a roof-top without interrupting service

Construction of a new Army camp required that a telephone cable be moved to a new position. New England Bell splicers are here shown joining two sections of the cable in its new location along the Cape Cod Canal

After fire had destroyed the communication center at Norfolk Naval Base on the morning of January 26, 1941, a temporary switchboard was installed by The Chesapeake and Potomac Telephone Company. This photograph was taken three days after the fire

Army telephone men are being trained by a Southwestern Bell instructor to operate this four-position switchboard at Fort Sill

The expansion required for telephone service to an Army camp is well illustrated by the history of the Mt. Holly, New Jersey, Central Office. Twelve positions have been added to the original ten and twelve more will shortly be in service



Defense preparations have made it necessary for the Southern California Telephone Company to increase the supplies at its pole yard. Here a "handful" of poles is being unloaded from a flat car

"No-Such-Number" Tone for Dial Systems

By M. E. KROM
Switching Development

OCCASIONALLY a customer's error in dialing results in his reaching a group of numbers not assigned for service. In such cases a tone may be used to inform the customer of his error, and the "no-such-number" tone has been developed for this purpose. A distinctive tone was desired, which could be easily remembered and associated with the idea of disconnecting and then dialing the number again. Various combinations of existing tones were tried but none was distinctive enough to prevent confusion with those used to convey other information. An entirely new tone was developed which varies continuously in frequency, like that of a siren, alternately rising and falling at half-second intervals. Its sound is quite different from any other tone used in the Bell System.

A wave-form of the tone is shown in Figure 1; the fundamental frequency at the lowest pitch is 200 cycles per second, and at the highest pitch 400 cycles. Harmonics up to 6000 cycles are in both tones as shown in Figure 2; these give the tones a richness not found in single-frequency waves.

The circuit used to supply this tone is shown in Figure 3. A relaxation oscillator which consists of a vacuum tube T1, the condenser C1 and resistance R1 generates a tone whose frequency is a function of the potential on the grid of the tube. This grid potential is made to vary through a range of approximately one-half volt by the rate of charge and discharge of the condenser C2 through the resistance R4. With the relay INT alternately operated and released every half second the fundamental frequency varies between approximately 200 cycles and 400 cycles per second. Potentiometers P1 and P2 are maintained at one-half volt difference in potential by resistances R2 and R3 in the filament circuit. Since these two potentiometers are similar and have a shaft that is common to both, their rotor terminals always differ in potential by one-half volt.

Potentiometers, rather than fixed potentials, are employed to permit compensation for variations in the vacuum tube characteristics. The tone circuit operates from the 48-volt central-office battery and variations in voltage are compensated by a bal-

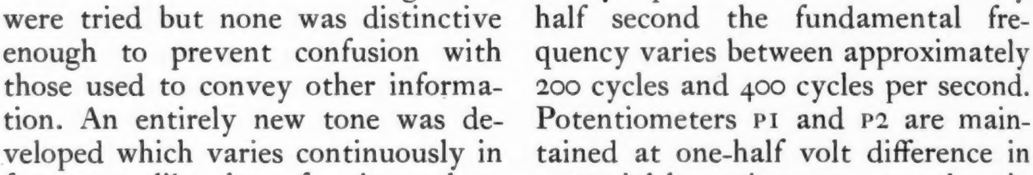


Fig. 1—The "no-such-number" tone is a train of oscillations whose fundamental frequency varies between 200 and 400 vibrations per second

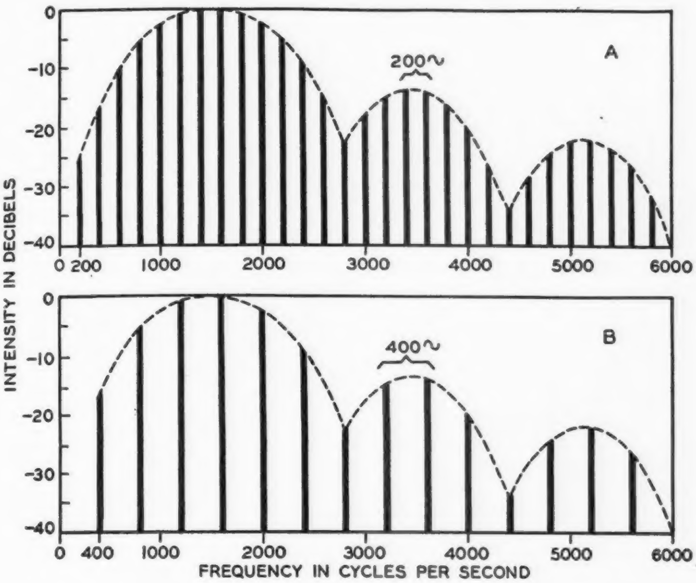


Fig. 2—Each oscillation of the tone consists of a fundamental and many harmonics. The envelope of the intensities of the harmonics is substantially the same for any fundamental frequency between 200 and 400 vibrations per second

above that of the dial and busy tones. Relay TO functions as the output transformer. Its output winding has a low internal impedance to allow for large fluctuations in load without appreciably affecting the output level. The potentiometer P3 permits adjusting the output to a satisfactory level. There is a difference of only 7 db between the no-load and the full-load conditions. The amplifier stage also serves to isolate the load circuit from the generating circuit, thereby preventing variations in load impedance from affecting the character of the tone.

last lamp. In practice the tone is connected to vacant code trunks in the panel and crossbar systems and to vacant local selector levels in the step-by-step system.

The tone is amplified by the vacuum tube T2. This raises the level

To lengthen the life of the vacuum tubes, the plate circuits are closed only when the tone is required. The filaments are continuously heated, however, to maintain the circuit in

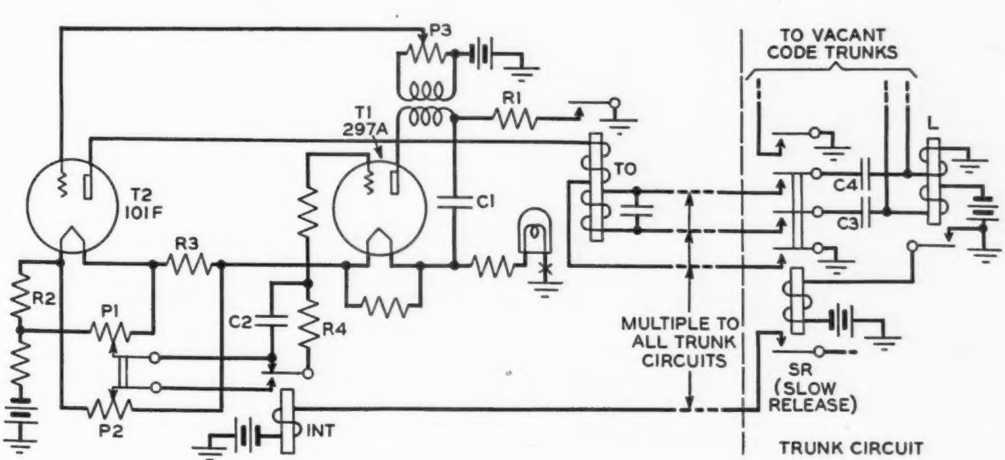


Fig. 3—The tone is generated by a relaxation oscillator which consists of vacuum tube T1, *condenser* C1, *and resistance* R1. *The frequency of the tone is controlled by the rate of charge and discharge of condenser* C2

readiness for instant service. This demand is indicated by the operation of relay SR through the associated relay L. One L relay is connected directly to each vacant code trunk and operates as soon as the trunk is seized. The relay SR releases slowly to hold during dial pulses, if the subscriber continues to dial after the trunk is seized. Operation of the relay SR starts the tone circuit immediately by connecting the plate battery to the vacuum tubes. It also applies the ground pulses to operate the relay INT and cuts the tone through to the associated trunk. The tone is applied to the trunk through condensers C3 and C4 to provide a high tone level and to minimize noise coupling with other circuits. The circuit can supply tone for twenty trunks simultaneously, which is more than will be required for any one central-office unit. Ordinarily one regular and one reserve tone-generating circuit will be provided so that transfer from one to the other can be made in case of failure in either circuit.

"No-such-number" tone is pleasing, yet distinctive and arresting enough to receive immediate attention from the subscriber. During field trials it has reduced circuit holding time on numbers wrongly dialed and resulted in a higher percentage of correct numbers on the second dialing.

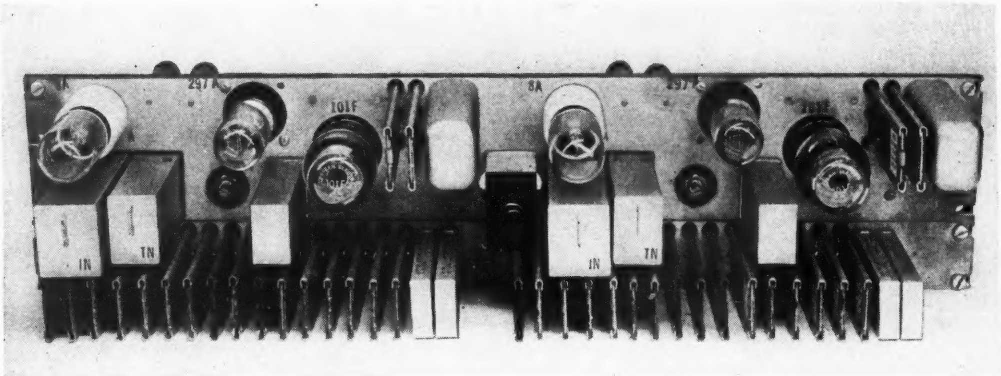
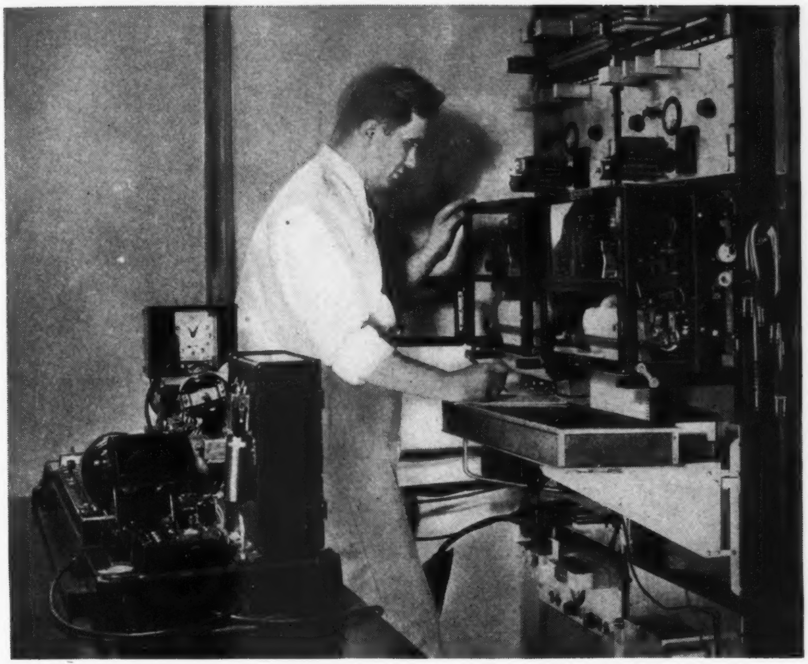


Fig. 4—"No-such-number" equipment warns the subscriber of his error by sounding a distinctive tone. One regular and one reserve generator are provided with a key for transferring from one to the other in case of failure of either



Studying the Performance of Toll Circuits

By L. L. GLEZEN
Toll Transmission Engineering

A MODERN long-distance telephone line is a far-flung and complex structure. It is subjected to a wide variety of weather conditions such as sleet, wind, and lightning, and to radical changes in temperature. Telephone circuits associated with such a line include a great number of pieces of intricate electrical apparatus, which are necessary to preserve the original quality and volume of the transmitted signals. With a type-K carrier system, for example, there may be sixty repeaters in a thousand-mile circuit; sixty points, in other words, where the circuit passes through equipment such as equalizers and amplifiers, and where automatic adjustments are made to compensate for variations in loss. All the equipment is designed so that the net loss over each circuit will not vary by more than a small amount for all normal changes. Because of this complexity of equipment, it is particularly important in the field trial before commercial application to study the behavior of the circuits under all sorts of conditions, to perfect adjustments, and to weed out unsatisfactory elements. This work has been greatly aided in recent years by the use of a group of special recording equipment.

Some of the changes that occur in transmission over a toll line, such as those due to temperature variations, arise slowly, and may last for a considerable time; others, such as lightning disturbances, may endure only a few thousandths of a second. To

secure a record of all kinds of changes, therefore, it has seemed best to employ two types of apparatus. One, used primarily to record the slower changes, is a graphic meter that runs continuously. The chart moves a little over an inch in an hour, and gives a 24-hour record in a space of about thirty inches. The other is a string oscillograph that is set in motion only when a sudden change in transmission of appreciable magnitude occurs. It runs a predetermined but adjustable interval and is then automatically stopped, and restored to normal to be ready for the next sudden change.

When a circuit is to be studied, 1000-cycle testing power, at about the level used for normal transmission, is supplied to one end, and this recording equipment is connected at the other end. How long the test is continued will depend somewhat on conditions, but it is generally desirable to extend the test over a period of six or eight months so selected as to secure the extreme range of conditions. Under normal circumstances simultaneous records are made on at least two transmission paths to make sure the conditions recorded are representative.

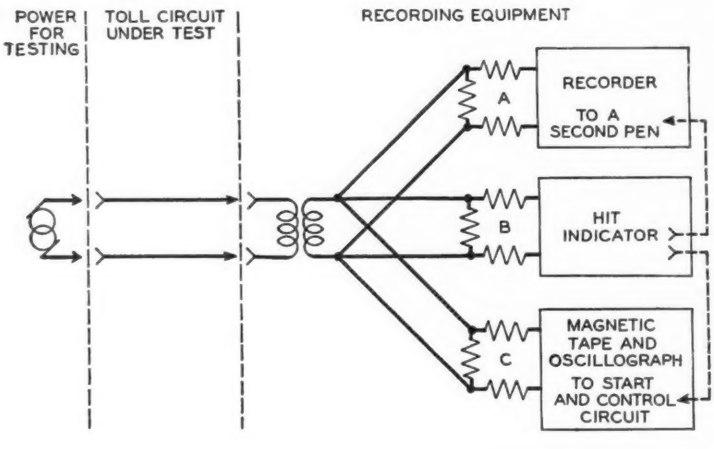


Fig. 1—Block schematic of recording equipment used for studying conditions on toll lines

The arrangement of the apparatus is shown in block schematic form in Figure 1. At the receiving end of the circuit under test, a terminating network is provided to match the impedances of the toll line and the recording apparatus, and to divide the circuit to be tested into three branches.

The "A" branch is that to the continuous recorder, which may be any of several types. In general it does not record changes in transmission that last less than one second, nor does it record the true value of changes lasting less than five or six seconds, or even longer for changes of large magnitude. The calibrated range of the recorder may be changed as desired, but it is usually ±3 or ±6 db. With such scales a change of 0.1 db occupies 0.1 or 0.05 inch of space.

The "B" branch comprises a "hit" indicator. A "hit" may be defined as a momentary disturbance due to a sudden change in the net loss of the circuit or the addition of energy to the circuit from some external source. Operation of the hit indicator starts the oscillograph in branch "C." It also causes a small deflection of a second pen on the recorder in branch A to enable the oscillograph record to be correlated with events on the continuous chart. The hit indicator is usually calibrated to operate on changes greater than 3 db and lasting longer than about 3 milliseconds. For changes lasting less than 3 milliseconds, the circuit has an integrating characteristic; a 20-db hit lasting

about one millisecond, for example, will operate it, as will a 10-db hit lasting two milliseconds. The hit indicator may be adjusted to operate on changes of other magnitudes as desired for special conditions.

The film of the oscillograph in branch C is normally at rest, and the lamp is operated at greatly reduced brilliancy. To bring the film up to speed and the lamp to full brilliancy requires an appreciable time—perhaps longer than the duration of the hit. To permit the hit to be fully and correctly recorded, it is necessary therefore to introduce some delay in the path between the line and the string of the oscillograph. The equipment used in branch C employs a magnetic tape recorder* for this purpose. A simplified schematic of the arrangement is shown in Figure 2. Other methods of accomplishing this with equipment used for somewhat similar purposes have already been described in the RECORD.†

The tape machine includes a recording unit, a reproducing unit, and a polarizing unit. The recording unit makes a continuous record on the tape of the energy on the line. After a short delay, depending on the adjustable distance between the recording and reproducing units, this record is picked up by the reproducing unit and operates the string of the oscillograph. Normally, however, no record is made on the film because the lamp is at reduced brilliancy and the film is stationary. After passing the reproducing unit, the tape passes around the driving pulley, makes a number of turns around the storage pulley, and then passes through the polarizing unit, which erases the record so that the tape will be in proper condition for again passing through the recording unit. This tape machine operates continuously in this manner whether hits are present or not.

When a hit of sufficient magnitude occurs, the hit indicator operates and actuates relays to start the film in the oscillograph and to bring the lamp to full brilliancy. By the time the part of the tape carrying the hit reaches

*RECORD, *Sept.*, 1937, *p.* 2.
†RECORD, *Jan.*, 1940, *pp.* 140 *and* 145.

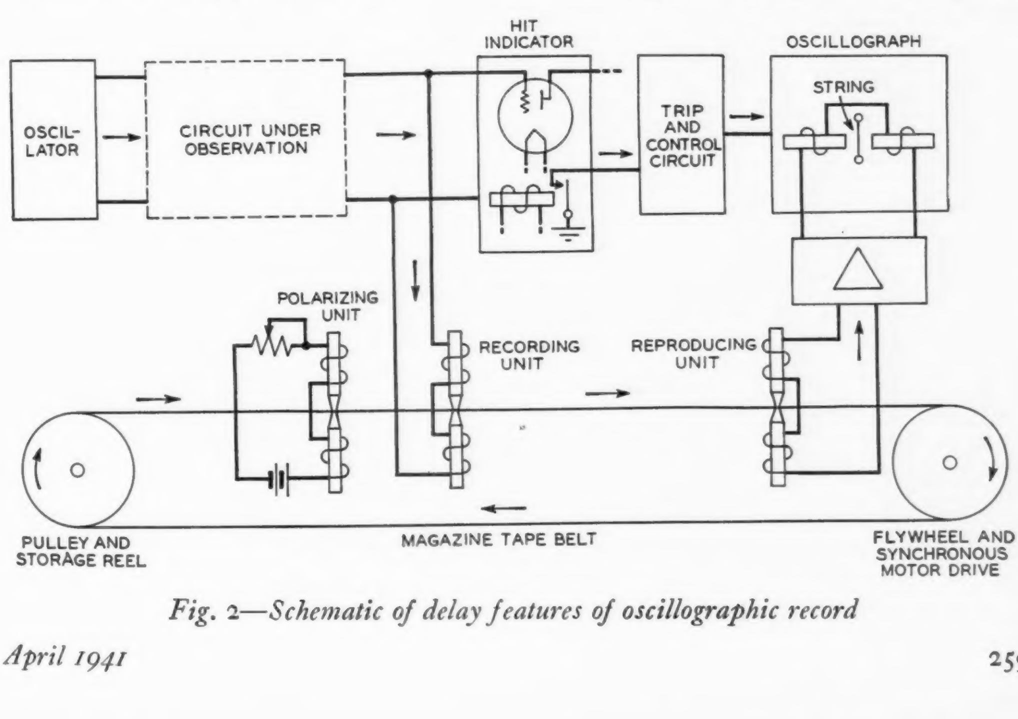


Fig. 2—Schematic of delay features of oscillographic record

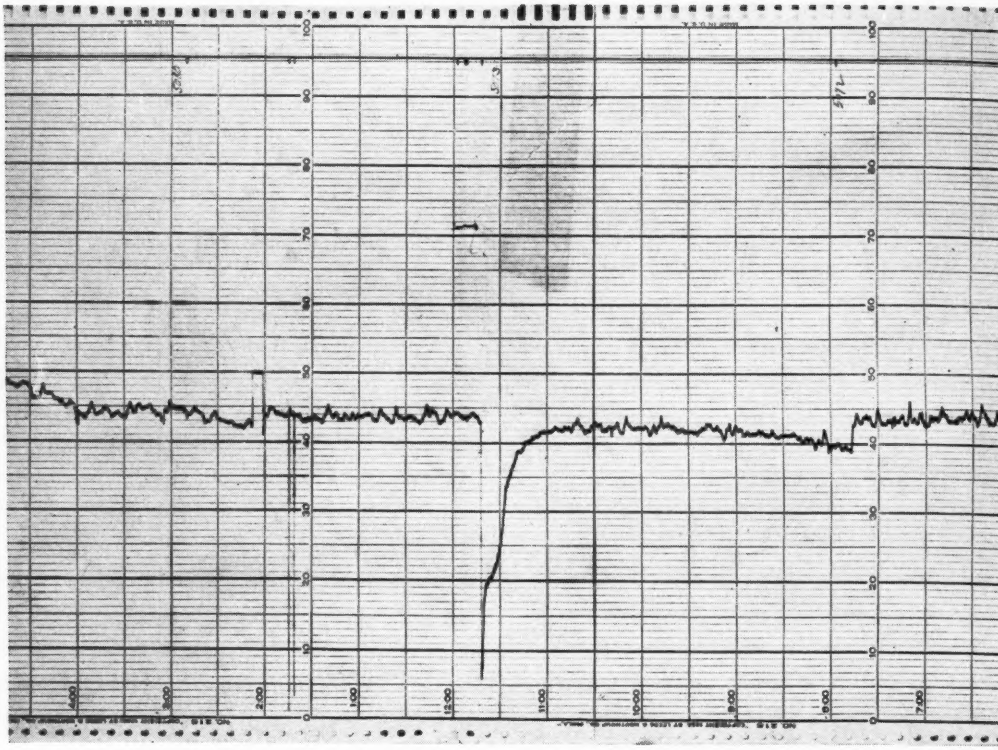


Fig. 3—Section of chart for an 11*-hour period. Ordinate scale divided by* 10 *is in dbs*

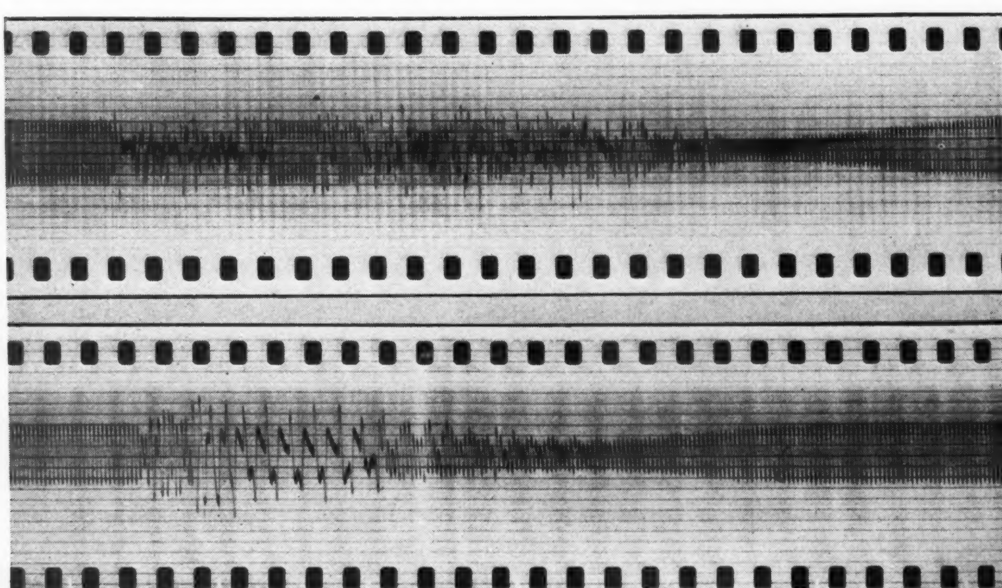


Fig. 4—Two oscillographic records showing typical effects of lightning disturbances

the reproducing unit the oscillograph is operating and a correct record of the hit disturbance can be made. As a matter of fact, the reproducing unit is spaced for sufficient delay to permit a small interval of normal transmission to be recorded before the hit occurs. After the record has been made, a sequence switch that controls the sequence of operations after the hit indicator has operated causes the date, location, and time of day to be photographed on the film immediately following its record of the transient disturbance. With this information available, the records of hits on the oscillograph film may be correlated with the data on the slow-speed chart and with other information.

A section of a chart covering an 11-hour period is shown in Figure 3. The heavy horizontal lines are 1 db apart, and the fine horizontal lines, 0.1 db. The first major change in level begins at about 11 A.M., and shows the effect of a gradually developing contact resistance. At about 11:40, probably some vibration or perhaps a sudden increase in the energy caused the contact to become good, and the testing energy suddenly returns to its normal level. Later, a little before and a little after 2 P.M., two sudden changes occur. The two before 2 P.M. were large enough to operate the hit indicator, as indicated by the deflections of the pen riding along the upper edge of the chart. The sudden changes immediately after two o'clock were not large enough to operate the hit indicator, since they were only about .75 db. A glance at the upper, or hit, curve shows that hits occurred just before 8 A.M. and just before noon that were too rapid to show on the slow-speed chart. These would appear on the oscillographic record for these times.

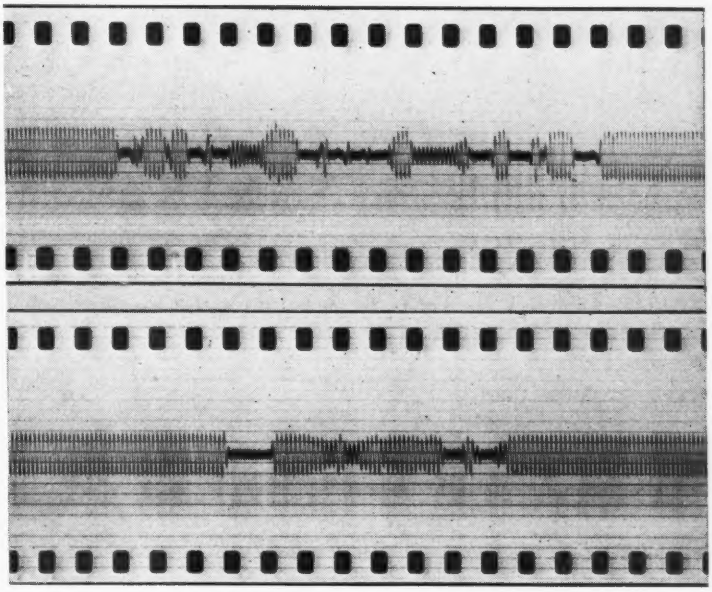


Fig. 5—Oscillographic record of contact trouble, below, and line swings, above

Typical oscillographic records are shown in Figures 4 and 5. Time flows from left to right, and the trace at uniform height at the right and left of each oscillogram is the normal 1,000-cycle testing wave. Figure 4 shows two effects of lightning. The lower of these oscillograms shows an unusual resonance effect near the central portion of the disturbance. The lower oscillogram of Figure 5 shows a form of contact trouble, while the upper one shows the effect of the conductors of an open-wire line swinging together, which sometimes occurs during a windstorm.

The charts and oscillograms are removed periodically for study. The

causes of certain of the disturbances may be fairly obvious, and steps may be taken to correct the conditions that are causing them. Other disturbances may be very difficult to identify, and special apparatus may be installed to measure them and determine their source. Nothing can be done, of course, about the occurrence of lightning, but often steps can be taken to minimize its effects on the circuit when these are known. Certain of the hits may indicate incorrect behavior of some elements of the circuit, behavior that could not be foreseen when the equipment was being designed. While new systems are being subjected to field trial, a determination of their performance through studies of this kind aids in disclosing difficulties that may be corrected or features that may be improved before large-scale commercial application of any system is made.

A typical installation of this apparatus is shown in the photograph at the head of this article. Here two of the slow-speed chart recorders are shown mounted on relay racks with their associated equipment. The oscillographic recorder is on the table at the left. The tape delay machine is in the flat horizontal cabinet projecting from the rack below the recorders.

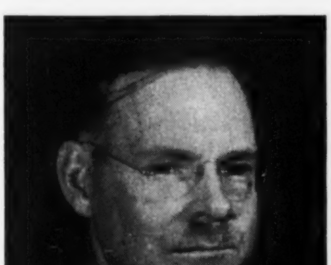
To clear the open-wire telephone lines from a large area where a munitions works is to be erected, the Illinois Bell Telephone Company has transferred a number of its important circuits to a cable shown here in the process of being laid by a buried-cable train

Contributors to this Issue

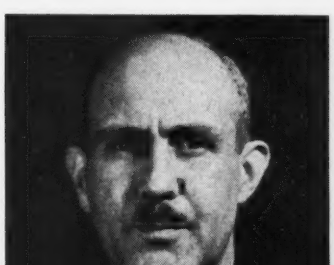
T. A. MARSHALL received a B.S. degree in Electrical Engineering from the University of Kansas in 1922, and immediately joined the Technical Staff of the Laboratories. After a year spent in the preparation of specifications in the Apparatus Development Department, he transferred to the toll development group. Here he was engaged in the design of test-board and switchboard circuits. More recently he has been occupied with the development of telegraph test-board facilities for the maintenance of telegraph and teletypewriter service.

L. L. GLEZEN entered the Long Lines Department of the A. T. & T. at Denver, Colorado, in 1917, after four years in the Electrical Engineering School of Colorado College. In 1918 he attended the Signal Officers Training School and received his commission as Second Lieutenant in the Signal Corps Reserve. In 1919 he attended the First Transmission School given by the A. T. & T. in New York and then returned to Denver as District Engineer, serving as such until 1922 when he was transferred to the Department of Development and Research. Here his work concerned the design of telephone repeaters, signaling equipment, public address systems, toll test boards and the development aspects of toll equipment maintenance. He transferred to the Systems Development Department of the Laboratories in 1934 with the consolidation of these departments and since 1935 has been in the Transmission Engineering Department where his work has concerned studies of the overall transmission performance of toll systems and toll transmission maintenance.

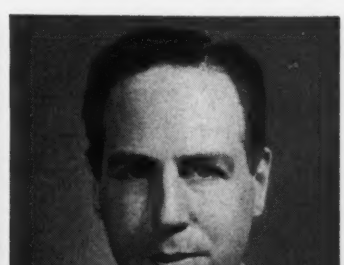
A. E. BACHELET joined the Toll System Department of the Laboratories in 1923. With the toll switching group he early engaged in studies and development work for improving toll lines for use of the rapidly growing broadcast industry. As these systems expanded, switching circuits had to be developed, and they have been steadily improved. He also carried on an extended fundamental study of the characteristics of gas-filled tubes—at the same time carrying on his program switching and transmission work.



T. A. Marshall



L. L. Glezen



A. E. Bachelet

M. E. Krom was graduated from Purdue University with the degree of B.S. in E.E. in 1923. He joined the Laboratories immediately after graduation and spent the first two years in the panel-dial laboratory. Then followed six months of relay design after which he was transferred to a laboratory group which handled ringing and tone studies. Nearly four years were spent in this work. Then he transferred to a group concerned with means of measuring and suppressing radio interference. In 1932 this work became a function of the ringing and tone studies group. Mr. Krom was transferred at the same time and has since been responsible for all radio interference tests and the development and application of radio filters to telephone equipment. Since this work no longer requires full time his efforts are now partly devoted to ringing and tone studies.

J. B. Hays received a B.S. degree in Electrical Engineering from the University of Colorado in 1936. After spending a year with the Southern California Edison Company he entered the Outside Plant Development Department of the Laboratories. During 1940 he was with the New England Telephone and Telegraph Company studying outside plant problems. He has now resumed his work in the electrical testing group of the Outside Plant Development Department.

M. E. Krom

J. B. Hays